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(54) Titre : COMPOSITIONS DE BLANCHIMENT COMPRENANT DES VARIANTES DE PROTEASE
MULTISUBSTITUEES
(54) Title: BLEACHING COMPOSITIONS COMPRISING MULTIPLY-SUBSTITUTED PROTEASE VARIANTS

(57) **Abrégé/Abstract:**

The present invention relates to bleaching compositions comprising a protease variant. One bleaching composition comprises a protease variant including a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to positions 230 and 232 of *Bacillus amyloliquefaciens* subtilisin a bleaching agent which is either an organic peroxyacid or a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and one or more cleaning adjunct materials. Methods for using the bleaching compositions are also provided.



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ABSTRACT

The present invention relates to bleaching compositions comprising a protease variant. One bleaching composition comprises a protease variant including a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to positions 230 and 232 of *Bacillus amyloliquefaciens* subtilisin a bleaching agent which is either an organic peroxyacid or a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and one or more cleaning adjunct materials. Methods for using the bleaching compositions are also provided.

BLEACHING COMPOSITIONS COMPRISING MULTIPLY-SUBSTITUTED PROTEASE VARIANTS

This application has been divided out of Canadian Patent Application Serial No. 2,306,894, the Canadian national phase of PCT/US1998/022482 filed internationally October 23, 1998 and published internationally as WO 1999/020726 on April 29, 1999.

FIELD OF THE INVENTION

The present invention relates to bleaching compositions, especially laundry detergents, which comprise one or more protease enzymes which are multiply-substituted protease variants and a bleaching system with one or more bleaching agents, especially bleach activators, and methods of using such bleaching compositions.

BACKGROUND OF THE INVENTION

Various types of enzymes have long been conventionally used in laundry detergents to assist in the removal of certain stains from fabrics. These stains are typically associated with lipid and protein soils. The enzymes, however, have proven less effective against other types of soils and stains.

U.S. Patent No. 5,677,272 to Ghosh et al., issued October 10, 1997, discloses bleaching compositions comprising: 1) a protease variant including substitutions of amino acid residues with other amino acid residues at positions corresponding to positions 76 in combination with one or more of the following positions 99, 101, 103, 104, 107, 123, 27, 105, 109, 126, 128, 135, 156, 166, 195, 197, 204, 206, 210, 216, 217, 218, 222, 260, 265 and/or 274 of *Bacillus amyloliquefaciens* subtilisin; 2) a bleaching agent; and 3) one or

more bleaching composition materials compatible with the protease variant and bleaching agent.

However, a need for more effective stain removal and/or dingy cleanup over the conventional bleaching compositions still exists.

By the present invention, it has been found that the combination of novel protease enzymes which are multiply-substituted protease variants and bleaching agents, especially bleach activators, provide enhanced and improved stain removal and/or dingy cleanup benefits over conventional bleaching compositions.

Accordingly, it is an object of the present invention to provide bleaching compositions, especially laundry detergent compositions, having improved stain and/or soil removal and/or dingy cleanup benefits and/or fabric cleaning benefits and /or bleaching properties.

These and other objects of the present invention will be apparent from the detailed description hereinafter.

SUMMARY OF THE INVENTION

The present invention meets the aforementioned needs in that it has been surprisingly discovered that the multiply-substituted protease variants of the present invention, when used in bleaching compositions provide improved and enhanced cleaning benefits, including, but not limited to, stain and/or soil removal and/or reduction and/or whiteness maintenance and/or dingy cleanup and/or spot and/or film removal and/or reduction, over conventional protease-containing bleaching compositions.

The multiply-substituted protease variants of the present invention are suitable for use in high and low density granular, heavy duty and light duty liquids, tablets, powders, gels, foams, sprays, paste, as well as synthetic detergent bar compositions, and other bleaching compositions.

In one aspect of the invention there is provided a bleaching composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the bleaching composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 126, 128, 130, 131, 133, 134, 137, 140, 141, 146,

158, 159, 160, 166, 167, 170, 173, 181, 182, 183, 184, 185, 188, 192, 194, 204, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 236, 237, 238, 240, 242, 243, 244, 245, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 259, 260, 261, 262, 263, 265, 269, 271, 272, or 275 of *Bacillus amyloliquefaciens* subtilisin, there is also a substitution at one or more of positions 123, 142, 147, 174, 177, 198, 203, 205, 222, 224, 227, 228, 230, 232, 246, 258, 268, 270 or 274; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to said positions 103 and 76, there is also a substitution of an amino acid residue at one or more of said amino acid residue positions other than said amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) one or more cleaning adjunct materials.

In one particular embodiment of the present invention there is provided a bleaching composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 230 and 232 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) one or more cleaning adjunct materials.

In yet another aspect of the present invention, a fabric bleaching composition comprising:

(a) an effective amount, preferably from about 0.0001% to about 10% by weight of the fabric bleaching composition, of the protease variant described above;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition;

(c) at least about 5% by weight of the fabric bleaching composition of a surfactant; and

3a

(d) at least about 5% by weight of the fabric bleaching composition of a builder, is provided.

In still another aspect of the present invention, a method for cleaning a fabric in need of cleaning comprising contacting the fabric with the fabric bleaching composition of the present invention is provided.

In still yet another aspect of the present invention, a dishwashing bleaching composition comprising:

- (a) an effective amount, preferably from about 0.0001% to about 10% by weight of the dishwashing composition, of a protease variant described above;
- (b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can

react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) from about 0.1% to about 10% by weight of a surfactant, is provided.

In still yet another aspect of the present invention, a method for cleaning a dish in need of cleaning comprising contacting the dish with the dishwashing bleaching composition of the present invention is provided.

In still yet another aspect of the present invention, a personal cleansing composition comprising:

(a) an effective amount, preferably from about 0.001% to about 5% by weight of the personal cleansing composition, of a protease variant described above;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) from about 0.1% to about 95% by weight of the personal cleansing composition of a surfactant system; and

(d) optionally, from about 0.05% to about 50% by weight of the personal cleansing composition of an enzyme stabilizer, is provided.

In still yet another aspect of the present invention, a method for personal cleansing of a part of the human or lower animal body in need of cleansing comprising contacting the part with the personal cleansing composition of the present invention is provided.

In still yet another aspect of the present invention, a bleaching composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the bleaching composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) one or more cleaning adjunct materials, is provided.

In still yet another aspect of the present invention, a fabric bleaching composition comprising:

(a) an effective amount, preferably from about 0.0001% to about 10% by weight of the fabric bleaching composition, of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition;

(c) at least about 5% by weight of the fabric bleaching composition, of a surfactant; and

(d) at least about 5% by weight of the fabric bleaching composition, of a builder, is provided.

In still another aspect of the present invention, a method for cleaning a fabric in need of cleaning comprising contacting the fabric with the fabric bleaching composition of the present invention is provided.

In still yet another aspect of the present invention, a dishwashing bleaching composition comprising:

(a) an effective amount, preferably from about 0.0001% to about 10% by weight of the fabric bleaching composition, of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) from about 0.1% to about 10% by weight of the dishwashing composition, of a surfactant, is provided.

In still yet another aspect of the present invention, a method for cleaning a dish in need of cleaning comprising contacting the dish with the dishwashing bleaching composition of the present invention is provided.

In still yet another aspect of the present invention, a personal cleansing composition comprising:

(a) an effective amount, preferably from about 0.001% to about 5% by weight of the personal cleansing composition, of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and

(c) from about 0.1% to about 95% by weight of the personal cleansing composition, of a surfactant system; and

(d) optionally, from about 0.05% to about 50% by weight of the personal cleansing composition, of an enzyme stabilizer, is provided.

In still yet another aspect of the present invention, a method for personal cleansing of a part of the human or lower animal body in need of cleansing comprising contacting the part with the personal cleansing composition of the present invention is provided.

Accordingly, it is an object of the present invention to provide bleaching compositions having a protease variant capable of providing improved and enhanced cleaning of fabrics, dishware, tableware, kitchenware, cookware and other hard surface substrates. It is a further object of the present invention to provide methods for fabric, dishware, tableware, kitchenware, cookware and other hard surface substrate cleansing via the use of the protease variant-containing bleaching compositions of the present invention.

These and other objects, features and advantages will be clear from the following detailed description, examples and appended claims.

All percentages, ratios and proportions herein are on a weight basis unless otherwise indicated.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 A-C depict the DNA and amino acid sequence for *Bacillus amyloliquefaciens* subtilisin and a partial restriction map of this gene.

Fig. 2 depicts the conserved amino acid residues among subtilisins from *Bacillus amyloliquefaciens* (BPN)' and *Bacillus lentus* (wild-type).

Figs. 3A and 3B depict the amino acid sequence of four subtilisins. The top line represents the amino acid sequence of subtilisin from *Bacillus amyloliquefaciens* subtilisin (also sometimes referred to as subtilisin BPN'). The second line depicts the amino acid sequence of subtilisin from *Bacillus subtilis*. The third line depicts the amino acid

sequence of subtilisin from *B. licheniformis*. The fourth line depicts the amino acid sequence of subtilisin from *Bacillus lentus* (also referred to as subtilisin 309 in PCT WO89/06276). The symbol * denotes the absence of specific amino acid residues as compared to subtilisin BPN'.

DETAILED DESCRIPTION OF THE INVENTION

The bleaching compositions employed in the present invention provide improved and enhanced cleaning of fabrics, dishware, kitchenware, tableware, and other hard surfaces as more fully described herein by removing and/or reducing soils and/or stains from the fabrics and other hard surfaces, and by removing and/or reducing spotting and/or filming from the dishware and other hard surfaces.

The bleaching systems in combination with the protease enzymes of the present invention are particularly efficient and effective at removing most types of soils from fabrics, including protein and lipid soils, dingy soils, and heavy soil loads, especially nucleophilic and body soils.

The protease enzymes, bleaching agents (including peroxyacids and bleaching systems) and cleaning adjunct materials useful herein, including preferred levels, are described in detail hereinafter.

I. Proteases - Proteases are carbonyl hydrolases which generally act to cleave peptide bonds of proteins or peptides. As used herein, "protease" means a naturally occurring protease or recombinant protease. Naturally-occurring proteases include α -aminoacylpeptide hydrolase, peptidylamino acid hydrolase, acylamino hydrolase, serine carboxypeptidase, metallocarboxypeptidase, thiol proteinase, carboxylproteinase and metalloproteinase. Serine, metallo, thiol and acid protease are included, as well as endo and exo-proteases.

The present invention includes protease enzymes which are non-naturally occurring carbonyl hydrolase variants (protease variants) having a different proteolytic activity, stability, substrate specificity, pH profile and/or performance characteristic as compared to the precursor carbonyl hydrolase from which the amino acid sequence of the variant is derived. Specifically, such protease variants have an amino acid sequence not found in nature, which is derived by replacement of a plurality of amino acid residues of a precursor protease with different amino acids. The precursor protease may be a naturally-occurring protease or recombinant protease. As stated earlier, the protease variants are designed to have trypsin-like specificity and preferably also be bleach stable.

The protease variants useful herein encompass the substitution of any of the nineteen naturally occurring L-amino acids at the designated amino acid residue positions. Such substitutions can be made in any precursor subtilisin (procaryotic, eucaryotic,

mammalian, etc.). Throughout this application reference is made to various amino acids by way of common one- and three-letter codes. Such codes are identified in Dale, M.W. (1989), Molecular Genetics of Bacteria, John Wiley & Sons, Ltd., Appendix B.

The protease variants useful herein are preferably derived from a *Bacillus subtilisin*. More preferably, the protease variants are derived from *Bacillus lentus* subtilisin and/or subtilisin 309.

Carbonyl Hydrolases - Carbonyl hydrolases are protease enzymes which hydrolyze compounds containing



bonds in which X is oxygen or nitrogen. They include naturally-occurring carbonyl hydrolases and recombinant carbonyl hydrolases. Naturally-occurring carbonyl hydrolases principally include hydrolases, e.g., peptide hydrolases such as subtilisins or metalloproteases. Peptide hydrolases include α -aminoacylpeptide hydrolase, peptidylamino acid hydrolase, acylamino hydrolase, serine carboxypeptidase, metallocarboxypeptidase, thiol proteinase, carboxylproteinase and metalloproteinase. Serine, metallo, thiol and acid protease's are included, as well as endo and exo-proteases.

Subtilisins - Subtilisins are bacterial or fungal proteases which generally act to cleave peptide bonds of proteins or peptides. As used herein, "subtilisin" means a naturally-occurring subtilisin or a recombinant subtilisin. A series of naturally-occurring subtilisins is known to be produced and often secreted by various microbial species. Amino acid sequences of the members of this series are not entirely homologous. However, the subtilisins in this series exhibit the same or similar type of proteolytic activity. This class of serine proteases share a common amino acid sequence defining a catalytic triad which distinguishes them from the chymotrypsin related class of serine proteases. The subtilisins and chymotrypsin related serine proteases both have a catalytic triad comprising aspartate, histidine and serine. In the subtilisin related proteases the relative order of these amino acids, reading from amino to carboxy terminus, is aspartate-histidine-serine. In the chymotrypsin related proteases, the relative order, however, is histidine-aspartate-serine. Thus, subtilisin herein refers to a serine protease having the catalytic triad of subtilisin related proteases. Examples include, but are not limited to, the subtilisins identified in Fig. 3 herein. Generally, and for purposes of the present invention, numbering of the amino acids in proteases corresponds to the numbers assigned to the mature *Bacillus amyloliquefaciens* subtilisin sequence presented in Fig. 1.

Protease Variants - A "protease variant" has an amino acid sequence which is derived from the amino acid sequence of a "precursor protease." The precursor proteases

include naturally-occurring proteases and recombinant proteases. The amino acid sequence of the protease variant is “derived” from the precursor protease amino acid sequence by substitution, deletion or insertion of one or more amino acids of the precursor amino acid sequence. Such modification is of the “precursor DNA sequence” which encodes the amino acid sequence of the precursor protease rather than manipulation of the precursor protease enzyme *per se*. Suitable methods for such manipulation of the precursor DNA sequence include methods disclosed herein, as well as methods known to those skilled in the art (see, for example, EP 0 328 299, WO 89/06279 and the U.S. patents and applications already referenced herein).

In a preferred embodiment, the protease variants which are protease enzymes useful in the present invention bleaching compositions comprise protease variants including a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 126, 128, 130, 131, 133, 134, 137, 140, 141, 146, 158, 159, 160, 166, 167, 170, 173, 181, 182, 183, 184, 185, 188, 192, 194, 204, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 236, 237, 238, 240, 242, 243, 244, 245, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 259, 260, 261, 262, 263, 265, 269, 271, 272, 274 or 275 of *Bacillus amyloliquefaciens* subtilisin, there is also a substitution at one or more of positions 123, 142, 147, 174, 177, 198, 203, 205, 222, 224, 227, 228, 230, 232, 246, 258, 268, 270 or 274; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin; and one or more cleaning adjunct materials.

While any combination of the above listed amino acid substitutions may be employed, the preferred protease variant enzymes useful for the present invention comprise the substitution, deletion or insertion of amino acid residues in the following combinations:

(1) a protease variant including substitutions of the amino acid residues at position 103 and at one or more of the following positions 236 and 245;

(2) a protease variant including substitutions of the amino acid residues at positions 103 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101,

76	103	104	183									
19	76	103	104									
13	76	103	104									
19	76	103	104									
76	103	104	184									
76	103	104	252									
76	103	104	259									
76	103	104	251									
76	86	103	104									
72	76	103	104	185								
76	103	104	237	274								
76	103	104	160									
76	103	104	228									
55	76	103	104	240								
76	103	104	254									
76	103	104	204									
76	103	104	204									
43	76	103	104									
76	103	104	159									
10	76	103	104	177								
58	76	103	104									
76	103	104	270									
76	103	104	185									
27	76	103	104									
76	103	104	262									
76	78	103	104									
24	76	103	104									
76	103	104	166	236	251							
17	76	103	104	237								
76	103	104	130									
76	103	104	109									
76	99	103	104	204								

76	103	104	181									
12	76	103	104									
76	103	104	212	271								
76	103	104	252	261								
76	103	104	242									
76	103	104	271									
12	76	103	104	242								
43	76	103	104	116	183							
76	103	104	258									
76	103	104	271									
61	76	103	104									
38	76	103	104	182	263							
76	103	104	182	272								
76	103	104	109	246								
76	87	103	104	206	249	265						
76	103	104	137	238	271							
103	104	228										
76	103	104	182	198								
21	76	103	104	182								
76	103	104	119	137								
76	103	104	137	248								
13	76	103	104	206								
76	103	104	206									
76	103	104	212	258								
58	76	103	104	271								
76	103	104	206	261								
4	76	103	104	206								
76	77	103	104	206								
76	103	104	158									
76	103	104	206									
4	76	103	104	159	217	251						
4	76	103	104	159	217	252						

76	77	103	104	133	185	251						
76	103	104	159	206	244							
4	76	103	104	188								
4	76	103	104	158								
76	77	103	104	185								
76	103	104	206	251								
48	76	103	104	111	159							
68	76	103	104	159	236							
42	76	103	104	159								
12	62	76	103	104	159							
42	76	103	104	159								
76	103	104	146	159								
76	103	104	159	238								
76	103	104	159	224								
76	103	104	212	268	271							
76	89	103	104									
76	87	103	104	212	271							
76	103	104	212	245	271							
76	103	104	134	141	212	271						
76	103	104	212	236	243	271						
76	103	104	109	245								
76	103	104	109	210								
20	62	76	103	104								
68	76	103	104	236								
68	76	103	104	159	236	271						
68	76	103	104	159	236	245						
68	76	103	104	159	217	236	271					
17	68	76	103	104								
68	76	103	104									
68	76	103	104	159	236							
68	75	76	103	104	159	236						
68	76	76	103	114	121	159	236	245				

12	68	76	103	104	159	236						
68	76	103	104	159	209	236	253					
68	76	103	104	117	159	184	236					
68	76	103	104	159	236	243						
68	76	103	104	159	236	245						
68	76	103	104	142	159							
68	76	103	104	123	159	236	249					
68	76	103	104	159	236	249						
76	103	104	222	245								
12	76	103	104	222	249							
76	103	104	173	222								
76	103	104	222	263								
21	76	103	104	222	237	263						
76	103	104	109	222								
76	103	104	109	222	271							
61	76	103	104	222								
76	103	104	137	222								
76	103	104	109	222	248							
76	103	104	222	249								
68	76	103	104	159	236	245	261					
68	76	103	104	141	159	236	245	255				
68	76	103	104	159	236	245	247					
68	76	103	104	159	174	204	236	245				
68	76	103	104	159	204	236	245					
68	76	103	104	133	159	218	236	245				
68	76	103	104	159	232	236	245					
68	76	103	104	159	194	203	236	245				
12	76	103	104	222	245							
76	103	104	232	245								
24	68	76	103	104	159	232	236	245				
68	103	104	159	232	236	245	252					
68	76	103	104	159	213	232	236	245	260			

12	76	103	104	222	244	245						
12	76	103	222	210	245							
12	76	103	104	130	222	245						
22	68	76	103	104								
68	76	103	104	184								
68	103	104	159	232	236	245	248	252				
68	103	104	159	232	236	245						
68	103	104	140	159	232	236	245	252				
43	68	103	104	159	232	236	245	252				
43	68	103	104	159	232	236	245					
43	68	103	104	159	232	236	245	252				
68	87	103	104	159	232	236	245	252	275			
12	76	103	104	130	222	245	248	262				
12	76	103	104	130	215	222	245					
12	76	103	104	130	222	227	245	262				
12	76	103	104	130	222	245	261					
76	103	104	130	222	245							
12	76	103	104	130	218	222	245	262	269			
12	57	76	103	104	130	222	245	251				
12	76	103	104	130	170	185	222	243	245			
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12	76	103	104	130	222	210	245					
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68	76	79	103	104	159	232	236	245				
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68	103	104	159	174	206	232	236	245				
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68	98	103	104	159	232	236	245					
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68	76	103	104	159	206	232	236	245				
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68	76	103	104	159	213	232	236	245	260	261		
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N76D	S103A	V104I	A228V									
P55S	N76D	S103A	V104I	S240T								
N76D	S103A	V104I	A254T									
N76D	S103A	I104N	N204T									
N76D	S103A	V104I	N204D									
N43S	N76D	S103A	V104I									
N76D	S103A	V104I	G159D									
R10H	N76D	S103A	V104I	V177A								
T58S	N76D	S103A	V104I									
N76D	S103A	V104I	A270V									
N76D	S103A	V104I	N185D									
K27N	N76D	S103A	V104I									
N76D	S103A	V104I	L262M									
N76D	S78P	S103A	V104I									
S24P	N76D	S103A	V104I									
N76D	S103A	V104I	S166G	Q236R	K251R							
H17L	N76D	S103A	V104I	K237E								
N76D	S103A	V104I	S130L									
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N76D	S103A	V104I	D181N									
Q12R	N76D	S103A	V104I									
N76D	S103A	V104I	S212P	E271V								
N76D	S103A	V104I	N252K	N261Y								
N76D	S103A	V104I	S242T									
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Q12R	N76D	S103A	V104I	S242T								
N43S	N76D	S103A	V104I	N116K	N183I							
N76D	S103A	V104I	G258R									
N76D	S103A	V104I	E271G									
G61R	N76D	S103A	V104I									
T38S	N76D	S103A	V104I	Q182R	Y263H							
N76D	S103A	V104I	Q182R	A272S								
N76D	S103A	V104I	Q109R	I246V								
N76D	S87G	S103A	V104I	Q206R	H249Q	S265G						
N76D	S103A	V104I	Q137R	N238Y	E271V							

S103A	V104I	A228T										
N76D	S103A	V104I	Q182R	I198V								
L21M	N76D	S103A	V104I	Q182R								
N76D	S103A	V104I	M119I	Q137R								
N76D	S103A	V104I	Q137R	N248S								
A13T	N76D	S103A	V104I	Q206R								
N76D	S103A	V104I	Q206R									
N76D	S103A	V104I	S212P	G258R								
T58S	N76D	S103A	V104I	E271G								
N76D	S103A	V104I	Q206E	N261D								
V4E	N76D	S103A	V104I	Q206E								
N76D	N77D	S103A	V104I	Q206E								
N76D	S103A	V104I	A158E									
N76D	S103A	V104I	Q206E									
V4E	N76D	S103A	V104I	G159D	L217E	K251Q						
V4E	N76D	S103A	V104I	G159D	L217E	N252D						
N76D	N77D	S103A	V104I	A133T	N185D	K251T						
N76D	S103A	V104I	G159D	Q206E	V244A							
V4E	N76D	S103A	V104I	S188E								
V4E	N76D	S103A	V104I	A158E								
N76D	N77D	S103A	V104I	N185D								
N76D	S103A	V104I	Q206E	K251T								
A48T	N76D	S103A	V104I	L111M	G159D							
V68A	N76D	S103A	V104I	G159D	Q236H							
L42V	N76D	S103A	V104I	G159D								
Q12H	N62H	N76D	S103A	V104I	G159D							
L42I	N76D	S103A	V104I	G159D								
N76D	S103A	V104I	G146S	G159D								
N76D	S103A	V104I	G159D	N238S								
N76D	S103A	V104I	G159D	T224A								
N76D	S103A	V104I	S212P	V268F	E271V							
N76D	E89A	S103A	V104I									
N76D	S87R	S103A	V104I	S212P	E271V							
N76D	S103A	V104I	S212P	Q245L	E271V							
N76D	S103A	V104I	T134S	S141N	S212P	E271V						
N76D	S103A	V104I	S212P	Q236L	N243S	E271V						

N76D	S103A	V104I	Q109R	Q245R								
N76D	S103A	V104I	Q109R	P210L								
G20V	N62S	N76D	S103A	V104I								
V68A	N76D	S103A	V104I	Q236H								
V68A	N76D	S103A	V104I	G159D	Q236H	E271V						
V68A	N76D	S103A	V104I	G159D	Q236H	Q245R						
V68A	N76D	S103A	V104I	G159D	L217I	Q236H	E271V					
H17Q	V68A	N76D	S103A	V104I								
V68A	N76D	S103A	V104I									
V68A	N76D	S103A	V104I	G159D	Q236R							
V68A	L75R	N76D	S103A	V104I	G159D	Q236H						
V68A	N76D	N76D	S103A	A114V	V121I	G159D	Q236H	Q245R				
Q12R	V68A	N76D	S103A	V104I	G159D	Q236H						
V68A	N76D	S103A	V104I	G159D	Y209S	Q236H	T253K					
V68A	N76D	S103A	V104I	N117K	G159D	N184S	Q236H					
V68A	N76D	S103A	V104I	G159D	Q236H	N243I						
V68A	N76D	S103A	V104I	G159D	Q236H	Q245L						
V68A	N76D	S103A	V104I	A142V	G159D							
V68A	N76D	S103A	V104I	N123S	G159D	Q236H	H249Y					
V68A	N76D	S103A	V104I	G159D	Q236H	H249Q						
N76D	S103A	V104I	M222S	Q245R								
Q12R	N76D	S103A	V104I	M222S	H249R							
N76D	S103A	V104I	N173R	M222S								
N76D	S103A	V104I	M222S	Y263F								
L21M	N76D	S103A	V104I	M222S	K237R	Y263F						
N76D	S103A	V104I	Q109R	M222S								
N76D	S103A	V104I	Q109R	M222S	E271D							
G61R	N76D	S103A	V104I	M222S								
N76D	S103A	V104I	Q137R	M222S								
N76D	S103A	V104I	Q109R	M222S	N248S							
N76D	S103A	V104I	M222S	H249R								
V68A	N76D	S103A	V104I	G159D	Q236H	Q245R	N261D					
V68A	N76D	S103A	V104I	S141N	G159D	Q236H	Q245R	T255S				
V68A	N76D	S103A	V104I	G159D	Q236H	Q245R	R247H					
V68A	N76D	S103A	V104I	G159D	A174V	N204D	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	N204D	Q236H	Q245R					

V68A	N76D	S103A	V104I	A133V	G159D	N218D	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	N76D	S103A	V104I	G159D	A194I	V203A	Q236H	Q245R				
Q12R	N76D	S103A	V104I	M222S	Q245R							
N76D	S103A	V104I	A232V	Q245R								
S24T	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K					
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A			
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Q12R	N76D	S103A	M222S	P210T	Q245R							
Q12R	N76D	S103A	I104T	S130T	M222S	Q245R						
T22K	V68A	N76D	S103A	V104I								
V68A	N76D	S103A	V104I	N184D								
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R						
V68A	S103A	V104I	N140D	G159D	A232V	Q236H	Q245R	N252K				
N43S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
N43K	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
V68A	S87G	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K	R275S			
Q12R	N76D	S103A	I104T	S130T	M222S	Q245R	N248S	L262M				
Q12R	N76D	S103A	I104T	S130T	A215V	M222S	Q245R					
Q12R	N76D	S103A	I104T	S130T	M222S	V227A	Q245R	L262S				
Q12R	N76D	S103A	I104T	S130T	A215T	M222S	Q245R					
Q12R	N76D	S103A	I104T	S130T	M222S	Q245R	N261D					
N76D	S103A	I104T	S130T	M222S	Q245R							
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Q12R	S57P	N76D	S103A	I104T	S130T	M222S	Q245R	K251Q				
Q12R	N76D	S103A	I104T	S130T	R170S	N185D	M222S	N243D	Q245R			
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Q12R	N76D	S103A	I104T	S130T	M222S	P210S	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V					
V68A	S103A	V104I	N116D	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D					
R10C	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	V203E	A232V	Q236H	Q245R					

V68A	S103A	V104I	G159D	A232V	Q236H	K237E	Q245R					
V68A	N76D	I79N	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	N183D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A174V	Q206L	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	S188C	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A230T	A232V	Q236H	Q245R					
V68A	A98T	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A215T	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248S					
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	N76D	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				
N76D	S103A	V104I	A232V	Q236H	Q245R	L257V						
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	R275H				
N76D	S103A	V104I	L257V	R275H								
V68A	S103A	V104I	G159D	T224A	A232V	Q236H	Q245R	L257V				
N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V					
V68A	N76D	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	G211R	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	G211V	A232V	Q236H	Q245R				
Q12R	V68A	N76D	S103A	V104I	G159D	Y214L	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R				
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
G20R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S259G			
V68A	S87R	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	T260V			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261G				
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261W				
N76D	S103A	V104I	A232V	Q236H	S242P	Q245R						
V68A	N76D	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R				
Q12R	A48V	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
N76D	S103A	V104I	A232V	Q236H	Q245R							
N76D	S103A	V104I	G159D	Y192F	A232V	Q236H	Q245R					
N76D	S103A	V104I	V147I	G159D	A232V	Q236H	Q245R	N248S	K251R			
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	A272S			
V68A	N76D	S103A	V104I	G159D	N183K	Q206L	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S256R				

V68A	N76D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R				
K27R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	N116T	G159D	R170S	N185S	A232V	Q236H	Q245R		
G61E	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212P	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	S99N	G159D	N184D	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K					
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K			
G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	Y209F	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261D			
V68A	S103A	V104I	G159D	N185D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210T	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210S	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	N185D	P210L	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212A	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	T213S	A232V	Q236H	Q245R	N248D	N252K				
V68A	A103V	V104I	G159D	T213E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213G	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A215V	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216T	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216V	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216C	A232V	Q236H	Q245R	N248D	N252K			
G20A	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	N173D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	K251V	N252K			
V68A	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R	N248D	N252K			

V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252F				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252L				
P55S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252F			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T255V			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256N			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256E			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	L257R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	G258D			
I8V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N269D		
V68A	S103A	V104I	N116S	G159D	A232V	Q236H	Q245R	N248D	N252K	T260F		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261D			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	A232V	Q236H	Q245R	N248D	N252K					
S103A	V104I	G159D	A232S	Q236H	Q245R	N248D	N252K					
V68A	S103A	V104I	G159D	A232V	Q236R	Q245R	N248D	N252K				
N18S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245V	N248D	N252K				
V68A	N76D	S101T	S103A	V104I	G159D	T213R	N218S	A232V	Q236H	Q245R	T260A	
V68A	S103A	V104I	G159D	A228V	A232V	Q236H	Q245R	N248D	N252K			
T33S	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	N76D	E89D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A	
G61E	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	V205I	P210I	A232V	Q236H	Q245R					
G61E	V68A	S103A	V104I	S130A	G159D	A232V	Q236H	Q245R	N248D	N252K		
G61E	V68A	S103A	V104I	A133S	Q137R	G159D	A232V	Q236H	Q245R	N248D	N252K	
G61E	S103A	V104I	A133V	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248G	N252K				
V68A	S103A	V104I	G159D	N218S	A232V	Q236H	Q245R	N248D	N252K			
G61E	V68A	S103A	V104I	G159D	S160V	A232V	Q236H	Q245R	N248D	N252K		
S3L	G61E	V68A	N76D	S103A	V104I	A232V	Q236H	Q245R	N248D	N252K		
G61E	V68A	S103A	V104I	G159D	S167F	A232V	Q236H	Q245R	N248D	N252K		
G97E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
A98D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				

S99E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S101E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	S106E	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	Q109E	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261R				
S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K				
N62D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	S166D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	L217E	A232V	Q236H	Q245R	N248D	N252K				
G20R	N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	G159D	Q206R	L217E	A232V	Q236H	Q245R	N248D	N252K			
N62D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	S130G	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K				
K27N	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
T38G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
T38A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A			
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A	E271G		
V68A	N76D	S103A	V104I	G159D	Y209W	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	P210I	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	V205I	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	T260A			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A				
N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A230V	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	L126F	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	V205I	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R					
S103A	V104I	G159D	A230V	Q236H	Q245R							
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	T260A					

S103A	V104I	G159D	A232V	Q236H	Q245R							
V68A	S103A	V104I	G159D	A174V	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	A194S	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	L257V				
S103A	V104I	G159D	A232V	Q236H	Q245R	L257V						
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A	N261W		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	N261W				
S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A					
S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	L257V					
V68A	N76D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A		
Q12R	S103A	V104I	G159D	Y209W	T213R	A232V	Q236H	Q245R	T260A			
S103A	V104I	Y209W	A232V	Q236H	Q245R	L257V						
S103A	V104I	G159D	V205I	P210I	T213R	A232V	Q236H	Q245R	T260A			
S103A	V104I	G159D	V205I	Y209W	A232V	Q236H	Q245R	T260A				
V68A	S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R			
S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R	L257V			
S103A	V104I	G159D	V205I	Y209W	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R	T260A		
S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R				
S103A	V104I	G159D	Y209W	P210I	A232V	Q236H	Q245R					
S103A	V104I	G159D	V205I	P210I	A232V	Q236H	Q245R					
V68A	S103A	V104I	S128L	G159D	A232V	Q236H	Q245R					
A48V	S103A	V104I	G159D	A230V	Q236H	Q245R						
A48V	V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R				
A48V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
A48V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	N261W			
G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
Q12R	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
S101G	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
G102A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184S	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184G	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	A232V	Q236H	V244T	Q245R	N248D	N252K				

S103A	V104I	G159D	A232V	Q236H	V244A	Q245R	N248D	N252K				
N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K	S256R		
Q12R	N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	N185D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	Q206E	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	T213Q	A232V	Q236H	Q245R	N248D	N252K			
A98L	G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	N248D	N252K			
N62D	S103A	V104I	Q109R	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	G159D	S212G	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S101G	S103A	V104I	G159D	S212G	T213R	A232V	Q236H	Q245R	N248D	N252K	
S103A	V104I	G159D	A232V	Q245R	N248D	N252K						
S103A	V104I	G159D	A230V	Q245R								
N62D	S103A	V104I	S130G	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	S130G	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	S128G	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	S128L	G159D	A232V	Q236H	Q245R	N248D	N252K			
N62D	S101G	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	S128G	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	S128L	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260A			
S101G	S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K			
A98V	S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S99G	S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	V205I	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	A230V	Q236H	Q245R						
S101G	S103A	V104I	G159D	A194P	A232V	Q236H	Q245R	N248D	N252K			
N76D	S101G	S103A	V104I	G159D	A194P	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	A230V	A232V	Q236H	Q245R	N248D	N252K			
N62D	S103A	V104I	G159D	N185D	Q206E	T213R	A232V	Q236H	Q245R	N248D	N252K	E271Q

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table I except for the following substitution sets of Table III:

Table III

76	103	104	259							
76	86	103	104							
76	103	104	130							
76	99	103	104	204						
76	103	104	242							
76	103	104	104	182	198					
21	76	103	104	182						
76	103	104	119	137						
76	103	104	173	222						
61	76	103	104	222						
68	76	103	104	116	159	170	185	232	236	245

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table IV:

Table IV

76	103	104	222	245							
76	103	104	222	249							
68	103	104	159	232	236	245	252				
68	76	103	104	159	213	232	236	245	260		
22	68	76	103	104							
68	103	104	159	232	236	245	248	252			
68	103	104	159	232	236	245					
68	103	104	140	159	232	236	245	252			
43	68	103	104	159	232	236	245	252			
43	68	103	104	159	232	236	245				
12	76	103	104	130	222	245	261				
76	103	104	130	222	245						

68	103	104	159	232	236	245	257				
68	76	103	104	159	210	232	236	245			
68	103	104	159	224	232	236	245	257			
76	103	104	159	232	236	245	257				
68	76	103	104	159	211	232	236	245			
12	68	76	103	104	159	214	232	236	245		
68	76	103	104	159	215	232	236	245			
12	68	76	103	104	159	232	236	245			
20	68	76	103	104	159	232	236	245	259		
68	76	87	103	104	159	232	236	245	260		
68	76	103	104	159	232	236	245	261			
12	48	68	76	103	104	159	232	236	245		
76	103	104	159	192	232	236	245				
76	103	104	147	159	232	236	245	248	251		
12	68	76	103	104	159	232	236	245	272		
68	76	103	104	159	183	206	232	236	245		
68	76	103	104	159	232	236	245	256			
68	76	103	104	159	206	232	236	245			
27	68	76	103	104	159	232	236	245			
68	103	104	159	212	232	236	245	248	252		
103	104	159	232	236	245	248	252				
68	103	104	159	209	232	236	245	248	252		
68	103	104	109	159	232	236	245	248	252		
20	68	103	104	159	232	236	245	248	252		
68	103	104	159	209	232	236	245	248	252		
68	103	104	159	210	232	236	245	248	252		
68	103	104	159	212	232	236	245	248	252		
68	103	104	159	213	232	236	245	248	252		
68	103	104	213	232	236	245	248	252			
68	103	104	159	215	232	236	245	248	252		
68	103	104	159	216	232	236	245	248	252		
20	68	103	104	159	232	236	245	248	252		

68	103	104	159	232	236	245	248	252	255		
68	103	104	159	232	236	245	248	252	256		
68	103	104	159	232	236	245	248	252	260		
68	103	104	159	228	232	236	245	248	252		
68	76	89	103	104	159	210	213	232	236	245	260
68	103	104	159	218	232	236	245	248	252		

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table V:

Table V

V68A	S103A	V104I	G159D	A228V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	N218S	A232V	Q236H	Q245R	N248D	N252K		
G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	N76D	E89D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256R		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260R		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T255V		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256N		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252L			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	A215V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S216T	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S216V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	T213S	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S212C	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K		
G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	Y209F	A232V	Q236H	Q245R	N248D	N252K		

Q12R	N76D	S103A	I104T	S130T	M222S	Q245R	N261D				
N76D	S103A	I104T	S130T	M222S	Q245R						
N76D	S103A	V104I	M222S	H249R							
N76D	S103A	V104I	M222S	Q245R							
N76D	S103A	V104I	G159D	Y192F	A232V	Q236H	Q245R				
N76D	S103A	V104I	V147I	G159D	A232V	Q236H	Q245R	N248S	K251R		
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	A272S		
V68A	N76D	S103A	V104I	G159D	N183K	Q206L	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S256R			
V68A	N76D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R			
K27R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
Q12R	A48V	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261W			
V68A	N76D	S103A	V104I	G159D	G211R	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	G211V	A232V	Q236H	Q245R			
Q12R	V68A	N76D	S103A	V104I	G159D	Y214L	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R			
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
G20R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S259G		
V68A	N76D	S87R	S103A	V104I	G159D	A232V	Q236H	Q245R	T260V		
N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A		
T22K	V68A	N76D	S103A	V104I							
V68A	N76D	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R			
V68A	S103A	V104I	G159D	S212P	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	T224A	A232V	Q236H	Q245R	L257V			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252S				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	N140D	G159D	A232V	Q236H	Q245R	N252K			
N43S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K			
N43K	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R				
N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				

A highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 12/76/103/104/130/170/185/222/243/245;
 12/76/103/104/130/222/245/261; 12/76/103/104/130/222/245;
 12/76/103/104/222/245;
 61/68/103/104/159/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
 62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
 62/101/103/104/159/212/213/232/236/245/248/252;
 62/103/104/130/159/213/232/236/245/248/252; 68/103/104/159/232/236/245/248/252/270;
 68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
 68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
 68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
 68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
 68/76/103/104/159/236; 68/76/103/104/159/236/245;
 68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
 68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
 68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
 68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
 68/76/103/104/159/213/232/236/245/260; 68/103/104/159/236;
 68/76/103/104/159/210/232/236/245/260; 68/103/104/159/236/245;
 68/103/104/159/183/232/236/245/248/252; 68/76/103/104/159/236/245;
 68/103/104/232/236/245/257/275; 68/103/104/159/213/232/236/245;
 76/103/222/245; 76/103/104/222/245;
 76/103/104/159/232/236/245;
 76/103/104/159/213/232/236/245/260; 76/103/104/159;
 76/103/104/131/159/232/236/245/248/252; 97/103/104/159/232/236/245/248/252;
 98/102/103/104/159/212/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
 101/103/104/159/232/236/245/248/252; 102/103/104/159/232/236/245/248/252;
 103/104/159/232/236/245; 103/104/159/232/236/245/248/252;
 103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;
 103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
 103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
 103/104/159/230/236/245; 103/104/159/236/245;
 103/104/159/248/252/270; 103/104/131/159/232/236/245/248/252;
 103/104/159/205/209/232/236/245; and 103/104/159/232/236/245/257.

A more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/76D/103A/104T/130T/222S/245R;
 12R/76D/103A/104I/222S/245R;
 12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 12R/76D/103A/104T/130G/222S/245R/261D;
 12R/76D/103A/104T/130G/170S/185D/222S/243D/245R;
 61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
 62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
 68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/103A/104I/159D/236H;
 68A/103A/104I/159D/236H/245R;
 68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
 68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/209W/232V/236H/245R;
 68A/76D/103A/104I/159D/211R/232V/236H/245R;
 68A/76D/103A/104I/159D/215R/232V/236H/245R;
 68A/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/76D/103A/104I/159D/236H;
 68A/76D/103A/104I/159D/236H/245R;
 68A/76D/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/252K;
 68A/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/257V;
 68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/230V/232V/236H/245R;

68A/76D/103A/104I/159D/209W/232V/236H/245R;
 68A/103A/104I/232V/236H/245R/248D/257V/275H;
 68A/103A/104I/232V/236H/245R/257V/275H;
 68A/103A/104I/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210I/232V/236H/245R;
 68A/103A/104I/159D/210L/232V/236H/245R;
 68A/103A/104I/159D/213G/232V/236H/245R;
 76D/103A/222S/245R;
 76D/103A/104I/222S/245R;
 76D/103A/104I/159D/232V/236H/245R;
 76D/103A/104I/159D;
 76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
 76D/103A/104I/159D/213R/232V/236H/245R/260A;
 97E/103A/104I/159D/232V/236H/245R/248D/252K;
 98L/103A/104I/159D/232V/236H/245R/248D/252K;
 98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K;
 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/230V/236H/245R;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/159D/236H/245R;
 103A/104I/159D/248D/252K/270V;
 103A/104I/159D/232V/236H/245R;
 103A/104I/159D/205I/209W/232V/236H/245R;
 103A/104I/159D/232V/236H/245R/257V;
 103A/104I/159D/205I/209W/232V/236H/245R/257V;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
 103A/104I/159D/232V/245R/248D/252K.

An even more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/76/103/104/130/222/245/261;
 62/103/104/159/232/236/245/248/252;
 62/103/104/159/213/232/236/245/248/252;
 62/101/103/104/159/212/213/232/236/245/248/252;
 68/103/104/159/232/236/245;
 68/103/104/159/230/232/236/245;
 68/103/104/159/209/232/236/245;
 68/103/104/159/232/236/245/257;
 68/76/103/104/159/213/232/236/245/260;
 68/103/104/159/213/232/236/245/248/252;
 68/103/104/159/183/232/236/245/248/252;
 68/103/104/159/185/232/236/245/248/252;
 68/103/104/159/185/210/232/236/245/248/252;
 68/103/104/159/210/232/236/245/248/252;
 68/103/104/159/213/232/236/245;
 98/103/104/159/232/236/245/248/252;
 98/102/103/104/159/212/232/236/245/248/252;
 101/103/104/159/232/236/245/248/252;
 102/103/104/159/232/236/245/248/252;
 103/104/159/230/236/245;
 103/104/159/232/236/245/248/252;
 103/104/159/217/232/236/245/248/252;
 103/104/130/159/232/236/245/248/252;
 103/104/131/159/232/236/245/248/252;
 103/104/159/213/232/236/245/248/252; and
 103/104/159/232/236/245.

The most highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/76D/103A/104T/130T/222S/245R/261D;
 62D/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/209W/232V/236H/245R;
 68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;

68A/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/230V/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/257V;
 68A/103A/104I/159D/213G/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/213G/232V/236H/245R;
 98L/103A/104I/159D/232V/236H/245R/248D/252K;
 98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/230V/236H/245R;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K; and
 103A/104I/159D/232V/236H/245R.

In another preferred embodiment, the protease variants which are the protease enzymes useful in the cleaning compositions of the present invention comprise protease variants including a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin.

While any combination of the above listed amino acid substitutions may be employed, the preferred protease variant enzymes useful for the present invention comprise the substitution, deletion or insertion of amino acid residues in the following combinations:

(1) a protease variant including substitutions of the amino acid residues at position 62 and at one or more of the following positions 103, 104, 109, 159, 213, 232, 236, 245, 248 and 252;

(2) a protease variant including substitutions of the amino acid residues at position 212 and at one or more of the following positions 12, 98, 102, 103, 104, 159, 232, 236, 245, 248 and 252;

(3) a protease variant including substitutions of the amino acid residues at position 230 and at one or more of the following positions 68, 103, 104, 159, 232, 236 and 245;

(4) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(5) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions 103, 104, 236 and 245;

(6) a protease variant including substitutions of the amino acid residues at position 232 and 103 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(7) a protease variant including substitutions of the amino acid residues at position 232 and 104 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(8) a protease variant including substitutions of the amino acid residues at position 232 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(9) a protease variant including substitutions of the amino acid residues at position 232 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(10) a protease variant including substitutions of the amino acid residues at position 232, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(11) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(12) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 103, 104, 236 and 245;

(13) a protease variant including substitutions of the amino acid residues at positions 252 and 103 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(14) a protease variant including substitutions of the amino acid residues at positions 252 and 104 and at one or more of the following positions 12, 61, 62, 68, 97, 98,

101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(15) a protease variant including substitutions of the amino acid residues at positions 252 and 236 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(16) a protease variant including substitutions of the amino acid residues at positions 252 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(17) a protease variant including substitutions of the amino acid residues at positions 252, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270; and

(18) a protease variant including substitutions of the amino acid residues at position 257 and at one or more of the following positions 68, 103, 104, 205, 209, 210, 232, 236, 245 and 275.

A more preferred protease variant useful in the cleaning compositions of the present invention include a substitution set (one substitution set per row in the following Table VI) selected from the group consisting of:

Table VI

76	103	104	212	271								
76	103	104	252	261								
76	103	104	212	258								
4	76	103	104	159	217	252						
12	62	76	103	104	159							
76	103	104	212	268	271							
76	87	103	104	212	271							
76	103	104	212	245	271							
76	103	104	134	141	212	271						
76	103	104	212	236	243	271						
20	62	76	103	104								
68	76	103	104	159	232	236	245					
76	103	104	232	245								
24	68	76	103	104	159	232	236	245				

68	103	104	159	232	236	245	252					
68	76	103	104	159	213	232	236	245	260			
68	103	104	159	232	236	245	248	252				
68	103	104	159	232	236	245						
68	103	104	140	159	232	236	245	252				
43	68	103	104	159	232	236	245	252				
43	68	103	104	159	232	236	245					
43	68	103	104	159	232	236	245	252				
68	87	103	104	159	232	236	245	252	275			
68	103	104	159	232	236	245	257					
68	103	104	116	159	232	236	245					
68	103	104	159	232	236	245	248					
10	68	103	104	159	232	236	245					
68	103	104	159	203	232	236	245					
68	103	104	159	232	236	237	245					
68	76	79	103	104	159	232	236	245				
68	103	104	159	183	232	236	245					
68	103	104	159	174	206	232	236	245				
68	103	104	159	188	232	236	245					
68	103	104	159	230	232	236	245					
68	98	103	104	159	232	236	245					
68	103	104	159	215	232	236	245					
68	103	104	159	232	236	245	248					
68	76	103	104	159	232	236	245					
68	76	103	104	159	210	232	236	245				
68	76	103	104	159	232	236	245	257				
76	103	104	232	236	245	257						
68	103	104	159	232	236	245	257	275				
76	103	104	257	275								
68	103	104	159	224	232	236	245	257				
76	103	104	159	232	236	245	257					
68	76	103	104	159	209	232	236	245				
68	76	103	104	159	211	232	236	245				
12	68	76	103	104	159	214	232	236	245			
68	76	103	104	159	215	232	236	245				
12	68	76	103	104	159	232	236	245				

20	68	76	103	104	159	232	236	245	259			
68	87	76	103	104	159	232	236	245	260			
68	76	103	104	159	232	236	245	261				
76	103	104	232	236	242	245						
68	76	103	104	159	210	232	236	245				
12	48	68	76	103	104	159	232	236	245			
76	103	104	232	236	245							
76	103	104	159	192	232	236	245					
76	103	104	147	159	232	236	245	248	251			
12	68	76	103	104	159	232	236	245	272			
68	76	103	104	159	183	206	232	236	245			
68	76	103	104	159	232	236	245	256				
68	76	103	104	159	206	232	236	245				
27	68	76	103	104	159	232	236	245				
68	76	103	104	116	159	170	185	232	236	245		
61	68	103	104	159	232	236	245	248	252			
43	68	103	104	159	232	236	245	248	252			
68	103	104	159	212	232	236	245	248	252			
68	103	104	99	159	184	232	236	245	248	252		
103	104	159	232	236	245	248	252					
68	103	104	159	209	232	236	245	248	252			
68	103	104	109	159	232	236	245	248	252			
20	68	103	104	159	232	236	245	248	252			
68	103	104	159	209	232	236	245	248	252			
68	103	104	159	232	236	245	248	252	261			
68	103	104	159	185	232	236	245	248	252			
68	103	104	159	210	232	236	245	248	252			
68	103	104	159	185	210	232	236	245	248	252		
68	103	104	159	212	232	236	245	248	252			
68	103	104	159	213	232	236	245	248	252			
68	103	104	213	232	236	245	248	252				
68	103	104	159	215	232	236	245	248	252			
68	103	104	159	216	232	236	245	248	252			
20	68	103	104	159	232	236	245	248	252			
68	103	104	159	173	232	236	245	248	252			
68	103	104	159	232	236	245	248	251	252			

68	103	104	159	206	232	236	245	248	252			
68	103	104	159	232	236	245	248	252				
55	68	103	104	159	232	236	245	248	252			
68	103	104	159	232	236	245	248	252	255			
68	103	104	159	232	236	245	248	252	256			
68	103	104	159	232	236	245	248	252	260			
68	103	104	159	232	236	245	248	252	257			
68	103	104	159	232	236	245	248	252	258			
8	68	103	104	159	232	236	245	248	252	269		
68	103	104	116	159	232	236	245	248	252	260		
68	103	104	159	232	236	245	248	252	261			
68	103	104	159	232	236	245	248	252	261			
68	76	103	104	159	232	236	245	248	252			
68	103	104	232	236	245	248	252					
103	104	159	232	236	245	248	252					
68	103	104	159	232	236	245	248	252				
18	68	103	104	159	232	236	245	248	252			
68	103	104	159	232	236	245	248	252				
68	76	101	103	104	159	213	218	232	236	245	260	
68	103	104	159	228	232	236	245	248	252			
33	68	76	103	104	159	232	236	245	248	252		
68	76	89	103	104	159	210	213	232	236	245	260	
61	68	76	103	104	159	232	236	245	248	252		
103	104	159	205	210	232	236	245					
61	68	103	104	130	159	232	236	245	248	252		
61	68	103	104	133	137	159	232	236	245	248	252	
61	103	104	133	159	232	236	245	248	252			
68	103	104	159	232	236	245	248	252				
68	103	104	159	218	232	236	245	248	252			
61	68	103	104	159	160	232	236	245	248	252		
3	61	68	76	103	104	232	236	245	248	252		
61	68	103	104	159	167	232	236	245	248	252		
97	103	104	159	232	236	245	248	252				
98	103	104	159	232	236	245	248	252				
99	103	104	159	232	236	245	248	252				
101	103	104	159	232	236	245	248	252				

102	103	104	159	232	236	245	248	252				
103	104	106	159	232	236	245	248	252				
103	104	109	159	232	236	245	248	252				
103	104	159	232	236	245	248	252	261				
62	103	104	159	232	236	245	248	252				
103	104	159	184	232	236	245	248	252				
103	104	159	166	232	236	245	248	252				
103	104	159	217	232	236	245	248	252				
20	62	103	104	159	213	232	236	245	248	252		
62	103	104	159	213	232	236	245	248	252			
103	104	159	206	217	232	236	245	248	252			
62	103	104	159	206	232	236	245	248	252			
103	104	130	159	232	236	245	248	252				
103	104	131	159	232	236	245	248	252				
27	103	104	159	232	236	245	248	252				
38	103	104	159	232	236	245	248	252				
38	76	103	104	159	213	232	236	245	260			
68	76	103	104	159	213	232	236	245	260	271		
68	76	103	104	159	209	213	232	236	245	260		
68	76	103	104	159	210	213	232	236	245	260		
68	76	103	104	159	205	213	232	236	245	260		
68	76	103	104	159	210	232	236	245	260			
68	103	104	159	213	232	236	245	260				
76	103	104	159	213	232	236	245	260				
68	103	104	159	209	232	236	245					
68	103	104	159	210	232	236	245					
68	103	104	159	230	232	236	245					
68	103	104	159	126	232	236	245					
68	103	104	159	205	232	236	245					
68	103	104	159	210	232	236	245					
103	104	159	230	236	245							
68	103	104	159	232	236	245	260					
103	104	159	232	236	245							
68	103	104	159	174	232	236	245	257				
68	103	104	159	194	232	236	245	257				
68	103	104	159	209	232	236	245	257				

103	104	159	232	236	245	257						
68	76	103	104	159	213	232	236	245	260	261		
68	103	104	159	232	236	245	257	261				
103	104	159	213	232	236	245	260					
103	104	159	210	232	236	245	248	252				
103	104	159	209	232	236	245	257					
68	76	103	104	159	210	213	232	236	245	260		
12	103	104	159	209	213	232	236	245	260			
103	104	209	232	236	245	257						
103	104	159	205	210	213	232	236	245	260			
103	104	159	205	209	232	236	245	260				
68	103	104	159	205	209	210	232	236	245			
103	104	159	205	209	210	232	236	245	257			
103	104	159	205	209	232	236	245	257				
68	103	104	159	205	209	210	232	236	245	260		
103	104	159	205	209	210	232	236	245				
103	104	159	209	210	232	236	245					
103	104	159	205	210	232	236	245					
68	103	104	128	159	232	236	245					
48	103	104	159	230	236	245						
48	68	103	104	159	209	232	236	245				
48	68	103	104	159	232	236	245	248	252			
48	68	103	104	159	232	236	245	257	261			
102	103	104	159	212	232	236	245	248	252			
12	102	103	104	159	212	232	236	245	248	252		
101	102	103	104	159	212	232	236	245	248	252		
98	102	103	104	159	212	232	236	245	248	252		
102	103	104	159	213	232	236	245	248	252			
103	104	131	159	232	236	245	248	252				
103	104	159	184	232	236	245	248	252				
103	104	159	232	236	244	245	248	252				
62	103	104	159	213	232	236	245	248	252	256		
12	62	103	104	159	213	232	236	245	248	252		
101	103	104	159	185	232	236	245	248	252			
101	103	104	159	206	232	236	245	248	252			
101	103	104	159	213	232	236	245	248	252			

98	102	103	104	159	232	236	245	248	252			
101	102	103	104	159	232	236	245	248	252			
98	102	103	104	159	212	232	236	245	248	252		
98	102	103	104	159	212	232	236	248	252			
62	103	104	109	159	213	232	236	245	248	252		
62	103	104	159	212	213	232	236	245	248	252		
62	101	103	104	159	212	213	232	236	245	248	252	
103	104	159	232	245	248	252						
103	104	159	230	245								
62	103	104	130	159	213	232	236	245	248	252		
101	103	104	130	159	232	236	245	248	252			
101	103	104	128	159	232	236	245	248	252			
62	101	103	104	159	213	232	236	245	248	252		
62	103	104	128	159	213	232	236	245	248	252		
62	103	104	128	159	213	232	236	245	248	252		
101	103	104	159	232	236	245	248	252	260			
101	103	104	131	159	232	236	245	248	252			
98	101	103	104	159	232	236	245	248	252			
99	101	103	104	159	232	236	245	248	252			
101	103	104	159	212	232	236	245	248	252			
101	103	104	159	209	232	236	245	248	252			
101	103	104	159	210	232	236	245	248	252			
101	103	104	159	205	232	236	245	248	252			
101	103	104	159	230	236	245						
101	103	104	159	194	232	236	245	248	252			
76	101	103	104	159	194	232	236	245	248	252		
101	103	104	159	230	232	236	245	248	252			
62	103	104	159	185	206	213	232	236	245	248	252	271

An even more preferred protease variant useful in the cleaning compositions of the present invention include a substitution set (one substitution set per row in the following Table VII) selected from the group consisting of:

Table VII

N76D	S103A	V104I	S212P	E271V								
N76D	S103A	V104I	N252K	N261Y								

N76D	S103A	V104I	S212P	G258R								
V4E	N76D	S103A	V104I	G159D	L217E	N252D						
Q12H	N62H	N76D	S103A	V104I	G159D							
N76D	S103A	V104I	S212P	V268F	E271V							
N76D	S87R	S103A	V104I	S212P	E271V							
N76D	S103A	V104I	S212P	Q245L	E271V							
N76D	S103A	V104I	T134S	S141N	S212P	E271V						
N76D	S103A	V104I	S212P	Q236L	N243S	E271V						
G20V	N62S	N76D	S103A	V104I								
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R					
N76D	S103A	V104I	A232V	Q245R								
S24T	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K					
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R						
V68A	S103A	V104I	N140D	G159D	A232V	Q236H	Q245R	N252K				
N43S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
N43K	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
V68A	S87G	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K	R275S			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V					
V68A	S103A	V104I	N116D	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D					
R10C	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	V203E	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	K237E	Q245R					
V68A	N76D	I79N	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	N183D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A174V	Q206L	A232V	Q236H	Q245R				
V68A	S103A	V104I	G159D	S188C	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A230T	A232V	Q236H	Q245R					
V68A	A98T	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A215T	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248S					
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R					

V68A	N76D	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				
N76D	S103A	V104I	A232V	Q236H	Q245R	L257V						
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	R275H				
N76D	S103A	V104I	L257V	R275H								
V68A	S103A	V104I	G159D	T224A	A232V	Q236H	Q245R	L257V				
N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V					
V68A	N76D	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	G211R	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	G159D	G211V	A232V	Q236H	Q245R				
Q12R	V68A	N76D	S103A	V104I	G159D	Y214L	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R				
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
G20R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S259G			
V68A	S87R	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	T260V			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261G				
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261W				
N76D	S103A	V104I	A232V	Q236H	S242P	Q245R						
V68A	N76D	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R				
Q12R	A48V	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
N76D	S103A	V104I	A232V	Q236H	Q245R							
N76D	S103A	V104I	G159D	Y192F	A232V	Q236H	Q245R					
N76D	S103A	V104I	V147I	G159D	A232V	Q236H	Q245R	N248S	K251R			
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	A272S			
V68A	N76D	S103A	V104I	G159D	N183K	Q206L	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S256R				
V68A	N76D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R				
K27R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R				
V68A	N76D	S103A	V104I	N116T	G159D	R170S	N185S	A232V	Q236H	Q245R		
G61E	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212P	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	S99N	G159D	N184D	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K					
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K			

G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	Y209F	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261D			
V68A	S103A	V104I	G159D	N185D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210T	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	P210S	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	N185D	P210L	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212A	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S212E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	T213S	A232V	Q236H	Q245R	N248D	N252K				
V68A	A103V	V104I	G159D	T213E	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	T213G	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A215V	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216T	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216V	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	S216C	A232V	Q236H	Q245R	N248D	N252K			
G20A	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	N173D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	K251V	N252K			
V68A	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252F				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252L				
P55S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252F			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T255V			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256N			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256E			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	L257R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	G258D			

I8V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N269D		
V68A	S103A	V104I	N116S	G159D	A232V	Q236H	Q245R	N248D	N252K	T260E		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261R			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261D			
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	A232V	Q236H	Q245R	N248D	N252K					
S103A	V104I	G159D	A232S	Q236H	Q245R	N248D	N252K					
V68A	S103A	V104I	G159D	A232V	Q236R	Q245R	N248D	N252K				
N18S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245V	N248D	N252K				
V68A	N76D	S101T	S103A	V104I	G159D	T213R	N218S	A232V	Q236H	Q245R	T260A	
V68A	S103A	V104I	G159D	A228V	A232V	Q236H	Q245R	N248D	N252K			
T33S	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	N76D	E89D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A	
G61E	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	V205I	P210I	A232V	Q236H	Q245R					
G61E	V68A	S103A	V104I	S130A	G159D	A232V	Q236H	Q245R	N248D	N252K		
G61E	V68A	S103A	V104I	A133S	Q137R	G159D	A232V	Q236H	Q245R	N248D	N252K	
G61E	S103A	V104I	A133V	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248G	N252K				
V68A	S103A	V104I	G159D	N218S	A232V	Q236H	Q245R	N248D	N252K			
G61E	V68A	S103A	V104I	G159D	S160V	A232V	Q236H	Q245R	N248D	N252K		
S3L	G61E	V68A	N76D	S103A	V104I	A232V	Q236H	Q245R	N248D	N252K		
G61E	V68A	S103A	V104I	G159D	S167F	A232V	Q236H	Q245R	N248D	N252K		
G97E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
A98D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S99E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S101E	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	S106E	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	Q109E	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	N261R				
S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K				
N62D	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184D	A232V	Q236H	Q245R	N248D	N252K				

S103A	V104I	G159D	S166D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	L217E	A232V	Q236H	Q245R	N248D	N252K				
G20R	N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	G159D	Q206R	L217E	A232V	Q236H	Q245R	N248D	N252K			
N62D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	S130G	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K				
K27N	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
T38G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
T38A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A			
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A	E271G		
V68A	N76D	S103A	V104I	G159D	Y209W	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	P210I	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	V205I	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	T260A			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A				
N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	A230V	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	L126F	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	V205I	A232V	Q236H	Q245R					
V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R					
S103A	V104I	G159D	A230V	Q236H	Q245R							
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	T260A					
S103A	V104I	G159D	A232V	Q236H	Q245R							
V68A	S103A	V104I	G159D	A174V	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	A194S	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	L257V				
S103A	V104I	G159D	A232V	Q236H	Q245R	L257V						
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A	N261W		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	N261W				
S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A					
S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	L257V					

V68A	N76D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A		
Q12R	S103A	V104I	G159D	Y209W	T213R	A232V	Q236H	Q245R	T260A			
S103A	V104I	Y209W	A232V	Q236H	Q245R	L257V						
S103A	V104I	G159D	V205I	P210I	T213R	A232V	Q236H	Q245R	T260A			
S103A	V104I	G159D	V205I	Y209W	A232V	Q236H	Q245R	T260A				
V68A	S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R			
S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R	L257V			
S103A	V104I	G159D	V205I	Y209W	A232V	Q236H	Q245R	L257V				
V68A	S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R	T260A		
S103A	V104I	G159D	V205I	Y209W	P210I	A232V	Q236H	Q245R				
S103A	V104I	G159D	Y209W	P210I	A232V	Q236H	Q245R					
S103A	V104I	G159D	V205I	P210I	A232V	Q236H	Q245R					
V68A	S103A	V104I	S128L	G159D	A232V	Q236H	Q245R					
A48V	S103A	V104I	G159D	A230V	Q236H	Q245R						
A48V	V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R				
A48V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
A48V	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V	N261W			
G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
Q12R	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
S101G	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
G102A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K			
S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184S	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	N184G	A232V	Q236H	Q245R	N248D	N252K				
S103A	V104I	G159D	A232V	Q236H	V244T	Q245R	N248D	N252K				
S103A	V104I	G159D	A232V	Q236H	V244A	Q245R	N248D	N252K				
N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K	S256R		
Q12R	N62D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	N185D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	Q206E	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	T213Q	A232V	Q236H	Q245R	N248D	N252K			
A98L	G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	G102A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
A98L	G102A	S103A	V104I	G159D	S212G	A232V	Q236H	N248D	N252K			

N62D	S103A	V104I	Q109R	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	G159D	S212G	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S101G	S103A	V104I	G159D	S212G	T213R	A232V	Q236H	Q245R	N248D	N252K	
S103A	V104I	G159D	A232V	Q245R	N248D	N252K						
S103A	V104I	G159D	A230V	Q245R								
N62D	S103A	V104I	S130G	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	S130G	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	S128G	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	S128L	G159D	A232V	Q236H	Q245R	N248D	N252K			
N62D	S101G	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	S128G	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
N62D	S103A	V104I	S128L	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260A			
S101G	S103A	V104I	P131V	G159D	A232V	Q236H	Q245R	N248D	N252K			
A98V	S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S99G	S101G	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	P210I	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	V205I	A232V	Q236H	Q245R	N248D	N252K			
S101G	S103A	V104I	G159D	A230V	Q236H	Q245R						
S101G	S103A	V104I	G159D	A194P	A232V	Q236H	Q245R	N248D	N252K			
N76D	S101G	S103A	V104I	G159D	A194P	A232V	Q236H	Q245R	N248D	N252K		
S101G	S103A	V104I	G159D	A230V	A232V	Q236H	Q245R	N248D	N252K			
N62D	S103A	V104I	G159D	N185D	Q206E	T213R	A232V	Q236H	Q245R	N248D	N252K	E271Q

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table VI except for the following substitution set of Table VIII:

Table VIII

68	76	103	104	116	159	170	185	232	236	245
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Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table IX:

Table IX

68	103	104	159	232	236	245	252				
68	76	103	104	159	213	232	236	245	260		
68	103	104	159	232	236	245	248	252			
68	103	104	159	232	236	245					
68	103	104	140	159	232	236	245	252			
43	68	103	104	159	232	236	245	252			
43	68	103	104	159	232	236	245				
68	103	104	159	232	236	245	257				
68	76	103	104	159	210	232	236	245			
68	103	104	159	224	232	236	245	257			
76	103	104	159	232	236	245	257				
68	76	103	104	159	211	232	236	245			
12	68	76	103	104	159	214	232	236	245		
68	76	103	104	159	215	232	236	245			
12	68	76	103	104	159	232	236	245			
20	68	76	103	104	159	232	236	245	259		
68	76	87	103	104	159	232	236	245	260		
68	76	103	104	159	232	236	245	261			
12	48	68	76	103	104	159	232	236	245		
76	103	104	159	192	232	236	245				
76	103	104	147	159	232	236	245	248	251		
12	68	76	103	104	159	232	236	245	272		
68	76	103	104	159	183	206	232	236	245		
68	76	103	104	159	232	236	245	256			
68	76	103	104	159	206	232	236	245			
27	68	76	103	104	159	232	236	245			
68	103	104	159	212	232	236	245	248	252		
103	104	159	232	236	245	248	252				
68	103	104	159	209	232	236	245	248	252		
68	103	104	109	159	232	236	245	248	252		
20	68	103	104	159	232	236	245	248	252		

68	103	104	159	209	232	236	245	248	252		
68	103	104	159	210	232	236	245	248	252		
68	103	104	159	212	232	236	245	248	252		
68	103	104	159	213	232	236	245	248	252		
68	103	104	213	232	236	245	248	252			
68	103	104	159	215	232	236	245	248	252		
68	103	104	159	216	232	236	245	248	252		
20	68	103	104	159	232	236	245	248	252		
68	103	104	159	232	236	245	248	252	255		
68	103	104	159	232	236	245	248	252	256		
68	103	104	159	232	236	245	248	252	260		
68	103	104	159	228	232	236	245	248	252		
68	76	89	103	104	159	210	213	232	236	245	260
68	103	104	159	218	232	236	245	248	252		

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table X:

Table X

V68A	S103A	V104I	G159D	A228V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	N218S	A232V	Q236H	Q245R	N248D	N252K		
G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	N76D	E89D	S103A	V104I	G159D	P210L	T213R	A232V	Q236H	Q245R	T260A
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256R		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T260R		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	T255V		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K	S256N		
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252L			
V68A	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	A215V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S216T	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S216V	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	T213S	A232V	Q236H	Q245R	N248D	N252K			

V68A	S103A	V104I	G159D	P210L	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S212C	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	S212G	A232V	Q236H	Q245R	N248D	N252K		
S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K				
V68A	S103A	V104I	G159D	Y209W	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	Q109R	G159D	A232V	Q236H	Q245R	N248D	N252K		
G20R	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	Y209F	A232V	Q236H	Q245R	N248D	N252K		
N76D	S103A	V104I	G159D	Y192F	A232V	Q236H	Q245R				
N76D	S103A	V104I	V147I	G159D	A232V	Q236H	Q245R	N248S	K251R		
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	A272S		
V68A	N76D	S103A	V104I	G159D	N183K	Q206L	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S256R			
V68A	N76D	S103A	V104I	G159D	Q206R	A232V	Q236H	Q245R			
K27R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
Q12R	A48V	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	N261W			
V68A	N76D	S103A	V104I	G159D	G211R	A232V	Q236H	Q245R			
V68A	N76D	S103A	V104I	G159D	G211V	A232V	Q236H	Q245R			
Q12R	V68A	N76D	S103A	V104I	G159D	Y214L	A232V	Q236H	Q245R		
V68A	N76D	S103A	V104I	G159D	A215R	A232V	Q236H	Q245R			
Q12R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R			
G20R	V68A	N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	S259G		
V68A	N76D	S87R	S103A	V104I	G159D	A232V	Q236H	Q245R	T260V		
N76D	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				
V68A	N76D	S103A	V104I	G159D	T213R	A232V	Q236H	Q245R	T260A		
V68A	N76D	S103A	V104I	G159D	P210R	A232V	Q236H	Q245R			
V68A	S103A	V104I	G159D	S212P	A232V	Q236H	Q245R	N248D	N252K		
V68A	S103A	V104I	G159D	T224A	A232V	Q236H	Q245R	L257V			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252S				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K				
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N248D	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R					
V68A	S103A	V104I	N140D	G159D	A232V	Q236H	Q245R	N252K			
N43S	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K			
N43K	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R				

N43D	V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	N252K			
V68A	S103A	V104I	G159D	A232V	Q236H	Q245R	L257V				

A highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 61/68/103/104/159/232/236/245/248/252;
62/103/104/130/159/213/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
62/101/103/104/159/212/213/232/236/245/248/252;
68/103/104/159/232/236/245/248/252/270;
68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
68/76/103/104/159/213/232/236/245/260; 68/76/103/104/159/210/232/236/245/260;
68/103/104/159/183/232/236/245/248/252; 68/103/104/232/236/245/257/275;
68/103/104/159/213/232/236/245; 76/103/104/159/232/236/245;
76/103/104/159/213/232/236/245/260; 76/103/104/131/159/232/236/245/248/252;
97/103/104/159/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
98/102/103/104/159/212/232/236/245/248/252; 101/103/104/159/232/236/245/248/252;
102/103/104/159/232/236/245/248/252; 103/104/159/232/236/245;
103/104/159/248/252/270; 103/104/159/232/236/245/248/252;
103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;
103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
103/104/131/159/232/236/245/248/252; 103/104/159/205/209/232/236/245; and
103/104/159/232/236/245/257.

A more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/209W/232V/236H/245R;
68A/76D/103A/104I/159D/211R/232V/236H/245R;
68A/76D/103A/104I/159D/215R/232V/236H/245R;
68A/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/252K;
68A/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/257V;
68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/230V/232V/236H/245R;
68A/76D/103A/104I/159D/209W/232V/236H/245R;
68A/103A/104I/232V/236H/245R/248D/257V/275H;
68A/103A/104I/232V/236H/245R/257V/275H;
68A/103A/104I/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210I/232V/236H/245R;
68A/103A/104I/159D/210L/232V/236H/245R;
68A/103A/104I/159D/213G/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;

98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K;
 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/159D/248D/252K/270V;
 103A/104I/159D/232V/236H/245R;
 103A/104I/159D/205I/209W/232V/236H/245R;
 103A/104I/159D/232V/236H/245R/257V;
 103A/104I/159D/205I/209W/232V/236H/245R/257V;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
 103A/104I/159D/232V/245R/248D/252K.

Recombinant Proteases/Recombinant Subtilisins - A "recombinant protease" or "recombinant subtilisin" refers to a protease or subtilisin in which the DNA sequence encoding the naturally-occurring protease or subtilisin, respectively, is modified to produce a mutant DNA sequence which encodes the substitution, insertion or deletion of one or more amino acids in the protease or subtilisin amino acid sequence. Suitable modification methods are disclosed herein, and in U.S. Patent Nos. RE 34,606, 5,204,015 and 5,185,258.

Non-Human Proteases/Non-Human Subtilisins - "Non-human proteases" or "non-human subtilisins" and the DNA encoding them may be obtained from many procaryotic and eucaryotic organisms. Suitable examples of procaryotic organisms include gram negative organisms such as *E. coli* or *Pseudomonas* and gram positive bacteria such as *Micrococcus* or *Bacillus*. Examples of eucaryotic organisms from which carbonyl hydrolase and their genes may be obtained include yeast such as *Saccharomyces cerevisiae*, fungi such as *Aspergillus* sp. and non-human mammalian sources such as, for example, *bovine* sp. from which the gene encoding the protease chymosin or subtilisin chymosin can be obtained. A series of proteases and/or subtilisins can be obtained from various related species which have amino acid sequences which are not entirely homologous between the members of that series but which nevertheless exhibit the same or similar type of biological activity. Thus, non-human protease or non-human subtilisin as used herein have a functional definition which refers to proteases or subtilisins, respectively, which are associated, directly or indirectly, with procaryotic and eucaryotic sources.

Variant DNA Sequences - Variant DNA sequences encoding such protease or subtilisin variants are derived from a precursor DNA sequence which encodes a naturally-occurring or recombinant precursor enzyme.

In a preferred embodiment of the present invention, the variant DNA sequences are derived by modifying the precursor DNA sequence to encode the substitution, insertion or deletion of one or more specific amino acid residues encoded by the precursor DNA sequence corresponding to positions 103 in combination with one or more of the following positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin. More preferably, these variant DNA sequences encode the protease variants described herein.

In another preferred embodiment, these variant DNA sequences encode the substitution, insertion or deletion of one or more of the amino acid residues corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin. More preferably, these variant DNA sequences encode the protease variants described herein.

Although the amino acid residues identified for modification herein are identified according to the numbering applicable to *B. amyloliquefaciens* (which has become the conventional method for identifying residue positions in all subtilisins), the preferred precursor DNA sequences useful for the present invention is the DNA sequence of *Bacillus lentus* as shown in Fig. 3.

These recombinant DNA sequences encode protease variants having a novel amino acid sequence and, in general, at least one property which is substantially different from the same property of the enzyme encoded by the precursor protease DNA sequence. Such properties include proteolytic activity, substrate specificity, stability, altered pH profile and/or enhanced performance characteristics.

Specific substitutions corresponding to positions 103 in combination with one or more of the following positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27,

33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 wherein the numbered positions correspond to the naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins (such as *Bacillus lentus* subtilisin) are described herein. Further, specific substitutions corresponding to one or more of the following positions 62, 212, 230, 232, 252 and 257 wherein the numbered positions correspond to the naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins (such as *Bacillus lentus* subtilisin) are described herein. These amino acid position numbers refer to those assigned to the mature *Bacillus amyloliquefaciens* subtilisin sequence presented in Fig. 1. The present invention, however, is not limited to the use of mutation of this particular subtilisin but extends to precursor proteases containing amino acid residues at positions which are “equivalent” to the particular identified residues in *Bacillus amyloliquefaciens* subtilisin. In a preferred embodiment of the present invention, the precursor protease is *Bacillus lentus* subtilisin and the substitutions, deletions or insertions are made at the equivalent amino acid residue in *B. lentus* corresponding to those listed above.

A residue (amino acid) of a precursor protease is equivalent to a residue of *Bacillus amyloliquefaciens* subtilisin if it is either homologous (i.e., corresponding in position in either primary or tertiary structure) or analogous to a specific residue or portion of that residue in *Bacillus amyloliquefaciens* subtilisin (i.e., having the same or similar functional capacity to combine, react or interact chemically).

In order to establish homology to primary structure, the amino acid sequence of a precursor protease is directly compared to the *Bacillus amyloliquefaciens* subtilisin primary sequence and particularly to a set of residues known to be invariant in subtilisins for which sequence is known. For example, Fig. 2 herein shows the conserved residues as between *B. amyloliquefaciens* subtilisin and *B. lentus* subtilisin. After aligning the conserved residues, allowing for necessary insertions and deletions in order to maintain alignment (i.e.,

avoiding the elimination of conserved residues through arbitrary deletion and insertion), the residues equivalent to particular amino acids in the primary sequence of *Bacillus amyloliquefaciens* subtilisin are defined. Alignment of conserved residues preferably should conserve 100% of such residues. However, alignment of greater than 75% or as little as 50% of conserved residues is also adequate to define equivalent residues. Conservation of the catalytic triad, Asp32/His64/Ser221 should be maintained.

For example, in Fig. 3 the amino acid sequence of subtilisin from *Bacillus amyloliquefaciens*, *Bacillus subtilis*, *Bacillus licheniformis* (*carlsbergensis*) and *Bacillus lentus* are aligned to provide the maximum amount of homology between amino acid sequences. A comparison of these sequences shows that there are a number of conserved residues contained in each sequence. These conserved residues (as between BPN' and *B. lentus*) are identified in Fig. 2.

These conserved residues, thus, may be used to define the corresponding equivalent amino acid residues of *Bacillus lentus* (PCT Publication No. WO89/06279 published July 13, 1989), the preferred protease precursor enzyme herein, or the subtilisin referred to as PB92 (EP 0 328 299), which is highly homologous to the preferred *Bacillus lentus* subtilisin. The amino acid sequences of certain of these subtilisins are aligned in Figs. 3A and 3B with the sequence of *Bacillus amyloliquefaciens* subtilisin to produce the maximum homology of conserved residues. As can be seen, there are a number of deletion in the sequence of *Bacillus lentus* as compared to *Bacillus amyloliquefaciens* subtilisin. Thus, for example, the equivalent amino acid for Val165 in *Bacillus amyloliquefaciens* subtilisin in the other subtilisins is isoleucine for *B. lentus* and *B. licheniformis*. Thus, for example, the amino acid at position +76 is asparagine (N) in both *B. amyloliquefaciens* and *B. lentus* subtilisins. In the protease variants of the invention, however, the amino acid equivalent to +76 in *Bacillus amyloliquefaciens* subtilisin is substituted with aspartate (D). The abbreviations and one letter codes for all amino acids in the present invention conform to the Patent User Manual (GenBank, Mountain View, CA) 1990, p. 101.

"Equivalent residues" may also be defined by determining homology at the level of tertiary structure for a precursor protease whose tertiary structure has been determined by x-ray crystallography. Equivalent residues are defined as those for which the atomic coordinates of two or more of the main chain atoms of a particular amino acid residue of the precursor protease and *Bacillus amyloliquefaciens* subtilisin (N on N, CA on CA, C on C and O on O) are within 0.13nm and preferably 0.1nm after alignment. Alignment is achieved after the best model has been oriented and positioned to give the maximum overlap of atomic coordinates of non-hydrogen protein atoms of the protease in question to the *Bacillus amyloliquefaciens* subtilisin. The best model is the crystallographic model

giving the lowest R factor for experimental diffraction data at the highest resolution available.

$$R\ factor = \frac{\sum_h |F_o(h)| - |F_c(h)|}{\sum_h |F_o(h)|}$$

Equivalent residues which are functionally analogues to a specific residue of *Bacillus amyloliquefaciens* subtilisin are defined as those amino acids of the precursor protease which may adopt a conformation such that they either alter, modify or contribute to protein structure, substrate binding or catalysis in a manner defined and attributed to a specific residue of the *Bacillus amyloliquefaciens* subtilisin. Further, they are those residues of the precursor protease (for which a tertiary structure has been obtained by x-ray crystallography) which occupy an analogous position to the extent that, although the main chain atoms of the given residue may not satisfy the criteria of equivalence on the basis of occupying a homologous position, the atomic coordinates of at least two of the side chain atoms of the residue lie within 0.13nm of the corresponding side chain atoms of *Bacillus amyloliquefaciens* subtilisin. The coordinates of the three dimensional structure of *Bacillus amyloliquefaciens* subtilisin are set forth in EPO Publication No. 0 251 446 (equivalent to U.S. Patent No. 5,182,204 and can be used as outlined above to determine equivalent residues on the level of tertiary structure.

Some of the residues identified for substitution, insertion or deletion are conserved residues whereas others are not. In the case of residues which are not conserved, the replacement of one or more amino acids is limited to substitutions which produce a variant which has an amino acid sequence that does not correspond to one found in nature. In the case of conserved residues, such replacements should not result in natural-occurring sequence. The protease variants of the present invention include the mature forms of protease variants, as well as the pro- and pre-pro-forms of such protease variants. The prepro-forms are the preferred construction since this facilitates the expression, secretion and maturation of the protease variants.

“Prosequence” refers to a sequence of amino acids bound to the N-terminal portion of the mature form of a protease which when removed results in the appearance of the “mature” form of the protease. Many proteolytic enzymes are found in nature as translational proenzyme products and, in the absence of post-translational processing, are expressed in this fashion. A preferred prosequence for producing protease variants is the putative prosequence of *Bacillus amyloliquefaciens* subtilisin, although other protease prosequences may be used.

A “signal sequence” or “presequence” refers to any sequence of amino acids bound to the N-terminal portion of a protease or to the N-terminal portion of a proprotease which may participate in the secretion of the mature or pro forms of the protease. This definition

of signal sequence is a functional one, meant to include all those amino sequences encoded by the N-terminal portion of the protease gene which participate in the effectuation of the secretion of protease under native conditions. The present invention utilizes such sequences to effect the secretion of the protease variants as defined here. One possible signal sequence comprises the first seven amino acid residues of the signal sequence from *Bacillus subtilis* subtilisin fused to the remainder of the signal sequence of the subtilisin from *Bacillus lentus* (ATCC 21536).

A “prepro” form of a protease variant consists of the mature form of the protease having a prosequence operably linked to the amino terminus of the protease and a “pre” or “signal” sequence operably linked to the amino terminus of the prosequence.

“Expression vector” refers to a DNA construct containing a DNA sequence which is operably linked to a suitable control sequence capable of effecting the expression of said DNA in a suitable host. Such control sequences include a promoter to effect transcription, an optional operator sequence to control such transcription, a sequence encoding suitable mRNA ribosome binding sites and sequences which control termination of transcription and translation. The vector may be a plasmid, a phage particle, or simply a potential genomic insert. Once transformed into a suitable host, the vector may replicate and function independently of the host genome, or may, in some instances, integrate into the genome itself. In the present specification, “plasmid” and “vector” are sometimes used interchangeably as the plasmid is the most commonly used form of vector at present. However, the invention is intended to include such other forms of expression vectors which serve equivalent functions and which are, or become, known in the art.

The “host cells” used in the present invention generally are procaryotic or eucaryotic hosts which preferably have been manipulated by the methods disclosed in US Patent RE 34,606 to render them incapable of secreting enzymatically active endoprotease. A preferred host cell for expressing protease is the *Bacillus* strain BG2036 which is deficient in enzymatically active neutral protease and alkaline protease (subtilisin). The construction of strain BG2036 is described in detail in US Patent 5,264,366. Other host cells for expressing protease include *Bacillus subtilis* 168 (also described in US Patent RE 34,606 and U.S. Patent No. 5,264,366), as well as any suitable *Bacillus* strain such as *B. licheniformis*, *B. lentus*, etc.

Host cells are transformed or transfected with vectors constructed using recombinant DNA techniques. Such transformed host cells are capable of either replicating vectors encoding the protease variants or expressing the desired protease variant. In the case of vectors which encode the pre- or prepro-form of the protease variant, such variants, when expressed, are typically secreted from the host cell in to the host cell medium.

“Operably linked, “when describing the relationship between two DNA regions, simply means that they are functionally related to each other. For example, a prosequence is operably linked to a peptide if it functions as a signal sequence, participating in the secretion of the mature form of the protein most probably involving cleavage of the signal sequence. A promoter is operably linked to a coding sequence if it controls the transcription of the sequence; a ribosome binding site is operably linked to a coding sequence if it is positioned so as to permit translation.

The genes encoding the naturally-occurring precursor protease may be obtained in accord with the general methods known to those skilled in the art. The methods generally comprise synthesizing labeled probes having putative sequences encoding regions of the protease of interest, preparing genomic libraries from organisms expressing the protease, and screening the libraries for the gene of interest by hybridization to the probes. Positively hybridizing clones are then mapped and sequenced.

The cloned protease is then used to transform a host cell in order to express the protease. The protease gene is then ligated into a high copy number plasmid. This plasmid replicates in hosts in the sense that it contains the well-known elements necessary for plasmid replication: a promoter operably linked to the gene in question (which may be supplied as the gene's own homologous promoter if it is recognized, i.e. transcribed by the host), a transcription termination and polyadenylation region (necessary for stability of the mRNA transcribed by the host from the protease gene in certain eucaryotic host cells) which is exogenous or is supplied by the endogenous terminator region of the protease gene and, desirably, a selection gene such as an antibiotic resistance gene that enables continuous cultural maintenance of plasmid-infected host cells by growth in antibiotic-containing media. High copy number plasmids also contain an origin of replication for the host, thereby enabling large numbers of plasmids to be generated in the cytoplasm without chromosomal limitation. However, it is within the scope herein to integrate multiple copies of the protease gene into host genome. This is facilitated by procaryotic and eucaryotic organisms which are particularly susceptible to homologous recombination. The gene can be a natural *B. lentus* gene. Alternatively, a synthetic gene encoding a naturally-occurring or mutant precursor protease may be produced. In such an approach, the DNA and/or amino acid sequence of the precursor protease is determined. Multiple, overlapping synthetic single-stranded DNA fragments are thereafter synthesized, which upon hybridization and ligation produce a synthetic DNA encoding the precursor protease. An example of synthetic gene construction is set forth in Example 3 of US Patent 5,204,105.

Once the naturally-occurring or synthetic precursor protease gene has been cloned, a number of modifications are undertaken to enhance the use of the gene beyond synthesis

of the naturally-occurring precursor protease. Such modifications include the production of recombinant proteases as disclosed in US Patent RE 34,606 and EPO Publication No. 0 251 446 and the production of protease variants described herein.

The following cassette mutagenesis method may be used to facilitate the construction of the proteases variants of the present invention, although other methods may be used. First, the naturally-occurring gene encoding the protease is obtained and sequenced in whole or in part. Then the sequence is scanned for a point at which it is desired to make a mutation (deletion, insertion or substitution) of one or more amino acids in the encoded enzyme. The sequences flanking this point are evaluated for the presence of restriction sites for replacing a short segment of the gene with an oligonucleotide pool which, when expressed will encode various mutants. Such restriction sites are preferably unique sites within the protease gene so as to facilitate the replacement of the gene segment. However, any convenient restriction site which is not overly redundant in the protease gene may be used, provided the gene fragments generated by restriction digestion can be reassembled in proper sequence. If restriction sites are not present at locations within a convenient distance from the selected point (from 10 to 15 nucleotides), such sites are generated by substituting nucleotides in the gene in such fashion that neither the reading frame nor the amino acids encoded are changed in the final construction. Mutation of the gene in order to change its sequence to conform to the desired sequence is accomplished by M13 primer extension in accord with generally known methods. The task of locating suitable flanking regions and evaluating the needed changes to arrive at two convenient restriction site sequences is made routine by the redundancy of the genetic code, a restriction enzyme map of the gene and the large number of different restriction enzymes. Note that if a convenient flanking restriction site is available, the above method need be used only in connection with the flanking region which does not contain a site.

Once the naturally-occurring DNA or synthetic DNA is cloned, the restriction sites flanking the positions to be mutated are digested with the cognate restriction enzymes and a plurality of end termini-complementary oligonucleotide cassettes are ligated into the gene. The mutagenesis is simplified by this method because all of the oligonucleotides can be synthesized so as to have the same restriction sites, and no synthetic linkers are necessary to create the restriction sites. As used herein, proteolytic activity is defined as the rate of hydrolysis of peptide bonds per milligram of active enzyme. Many well known procedures exist for measuring proteolytic activity (K. M. Kalisz, "Microbial Proteinases," Advances in Biochemical Engineering/Biotechnology, A. Fiechter ed., 1988). In addition to or as an alternative to modified proteolytic activity, the variant enzymes of the present invention may have other modified properties such as K_m , k_{cat} , k_{cat}/K_m ratio and/or modified substrate specificity and/or modified pH activity profile. These enzymes can be tailored for the

particular substrate which is anticipated to be present, for example, in the preparation of peptides or for hydrolytic processes such as laundry uses.

In one aspect of the invention, the objective is to secure a variant protease having altered proteolytic activity as compared to the precursor protease, since increasing such activity (numerically larger) enables the use of the enzyme to more efficiently act on a target substrate. Also of interest are variant enzymes having altered thermal stability and/or altered substrate specificity as compared to the precursor. In some instances, lower proteolytic activity may be desirable, for example a decrease in proteolytic activity would be useful where the synthetic activity of the proteases is desired (as for synthesizing peptides). One may wish to decrease this proteolytic activity, which is capable of destroying the product of such synthesis. Conversely, in some instances it may be desirable to increase the proteolytic activity of the variant enzyme versus its precursor. Additionally, increases or decreases (alteration) of the stability of the variant, whether alkaline or thermal stability, may be desirable. Increases or decreases in k_{cat} , K_m or K_{cat}/K_m are specific to the substrate used to determine these kinetic parameters.

In another aspect of the invention, it has been determined that substitutions at positions corresponding to 103 in combination with one or more of the following positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin are important in modulating overall stability and/or proteolytic activity of the enzyme.

In a further aspect of the invention, it has been determined that substitutions at one or more of the following positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin are also important in modulating overall stability and/or proteolytic activity of the enzyme.

These substitutions are preferably made in *Bacillus lentus* (recombinant or native-type) subtilisin, although the substitutions may be made in any *Bacillus* protease.

Based on the screening results obtained with the variant proteases, the noted mutations in *Bacillus amyloliquefaciens* subtilisin are important to the proteolytic activity, performance and/or stability of these enzymes and the cleaning or wash performance of such variant enzymes.

Methods and procedures for making the enzymes used in the detergent and bleaching compositions of the present invention are known and are disclosed in PCT Publication No. WO 95/10615.

The enzymes of the present invention have trypsin-like specificity. That is, the enzymes of the present invention hydrolyze proteins by preferentially cleaving the peptide bonds of charged amino acid residues, more specifically residues such as arginine and lysine, rather than preferentially cleaving the peptide bonds of hydrophobic amino acid residues, more specifically phenylalanine, tryptophan and tyrosine. Enzymes having the latter profile have a chymotrypsin-like specificity. Substrate specificity as discussed above is illustrated by the action of the enzyme on two synthetic substrates. Protease's having trypsin-like specificity hydrolyze the synthetic substrate bVGR-pNA preferentially over the synthetic substrate sucAAPF-pNA. Chymotrypsin-like protease enzymes, in contrast, hydrolyze the latter much faster than the former. For the purposes of the present invention the following procedure was employed to define the trypsin-like specificity of the protease enzymes of the present invention:

A fixed amount of a glycine buffer at a pH of 10 and a temperature of 25 °C is added to a standard 10 ml test tube. 0.5 ppm of the active enzyme to be tested is added to the test tube. Approximately, 1.25 mg of the synthetic substrate per mL of buffer solution is added to the test tube. The mixture is allowed to incubate for 15 minutes at 25 °C. Upon completion of the incubation period, an enzyme inhibitor, PMSF, is added to the mixture at a level of 0.5 mg per mL of buffer solution. The absorbency or OD value of the mixture is read at a 410 nm wavelength. The absorbence then indicates the activity of the enzyme on the synthetic substrate. The greater the absorbence, the higher the level of activity against that substrate.

To then determine the specificity of an individual enzyme, the absorbence on the two synthetic substrate proteins may be converted into a specificity ratio. For the purposes of the present invention, the ratio is determined by the formula specificity of:

$$[\text{activity on sAAPF-pNA}]/[\text{activity on bVGR-pNA}]$$

An enzyme having a ratio of less than about 10, more preferably less than about 5 and most preferably less than about 2.5 may then be considered to demonstrate trypsin-like activity.

Such variants generally have at least one property which is different from the same property of the protease precursor from which the amino acid sequence of the variant is derived.

One aspect of the invention are compositions, such as detergent and bleaching compositions, for the treatment of textiles, dishware, tableware, kitchenware, cookware, and other hard surface substrates that include one or more of the variant proteases of the present invention. Protease-containing compositions can be used to treat for example: silk

or wool, as well as other types of fabrics, as described in publications such as RD 216,034, EP 134,267, US 4,533,359, and EP 344,259; and dishware, tableware, kitchenware, cookware, and other hard surface substrates as described in publications such as in US 5,478,742, US 5,346,822, US 5,679,630, and US 5,677,272.

II. Bleaching Agents - The bleaching compositions herein contain a bleaching agent, which preferably comprises from about 0.5 to about 20 wt.% of the composition. The bleaching agent is either a substantially insoluble, preferably solid, organic peroxyacid, or a bleaching system comprising a bleach activator and a peroxygen bleaching compound capable of yielding hydrogen peroxide, or a combination of both. The peracid which is in the composition, or which is formed by the combination of activator and peroxygen compound, preferably has a corresponding carboxylic acid that has a Hydrophilic-Lipophilic Balance ("H.L.B.") value which ranges from about 3 to about 6.5. Therefore, a method that can be used to characterize the preferred peroxyacids (from activators or as preformed peroxyacids) which are useful in the present invention is the "H.L.B. Scale" such as that described in Davies, J.T., Proc 2nd Internat. Congr. Surface Activity 1, 426, Butterworths, London (1957).

Such an H.L.B. Scale (Hydrophilic-Lipophilic Balance) has been used in the study of surface-active agents (surfactants) as a means to relate the distribution of a surface-active agent between a hydrophilic (water-like) and a lipophilic (oil-like) phase. In this manner, H.L.B. values can be used as an indication of the lipophilic (hydrophobic) character of the active bleaching species in the wash (i.e., the ability of the peroxyacid to partition out of the wash liquor and concentrate at the soil/fabric interface).

Set forth hereinafter in Table A are H.L.B. values which have been calculated for selected peroxyacids (as the corresponding carboxylic acids). The equation used to calculate the H.L.B. values can be set forth as:

$$HLB = \text{Sum (Hydrophilic Group Numbers)} - \text{Sum (Hydrophobic Group Numbers)} + 7.$$

The values for the Hydrophilic Group Numbers are [-C(O)OH & -N(H)C(O)- = 2.1] and the values for the Hydrophobic Group Numbers are [aliphatic/aromatic carbon = 0.475 & aliphatic carbon atoms between polar groups are 1/2 the value of an aliphatic carbon in a hydrocarbon chain = (0.475)/2]. For reference, an H.L.B. value >7 indicates that the material is preferentially water soluble and an H.L.B. value <7 indicates increasing surface-activity and hydrophobicity.

Table A

H.L.B. Values Provided by Various Peroxyacids

<u>Activator/Preformed Peroxyacid</u>	<u>Abbreviation</u>	<u>Peroxyacid</u>	<u>H.L.B.</u> <u>Corresponding</u> <u>Carboxylic Acid</u>
Tetra Acetyl Ethylene Diamine	TAED	CH ₃ C(O)OOH	8.6
DiPeroxyDodecane Dioic Acid	DPDDA	HOO(O)C(CH ₂)-10-C(O)OOH	6.5
Nonyl Amide of Peroxy Succinic Acid	NAPSA	CH ₃ (CH ₂) ₈ N(H)-C(O)(CH ₂) ₂ C(O)-OOH	6.4
BenzoylOxyBenzene Sulfonate	BOBS	C ₆ H ₅ C(O)OOH	6.3
Nonyl Amide of Peroxy Adipic Acid	NAPAA	CH ₃ (CH ₂) ₈ N(H)-C(O)(CH ₂) ₄ C(O)-OOH	6.0
NonanoylOxyBen-zene Sulfonate	NOBS	CH ₃ (CH ₂) ₇ C(O)-OOH	5.3
DecanoylOxyBen-zene Sulfonate	DOBS	CH ₃ (CH ₂) ₈ C(O)-OOH	4.8
PerLauric Acid	PLA	CH ₃ (CH ₂) ₁₀ C-(O)OOH	3.9

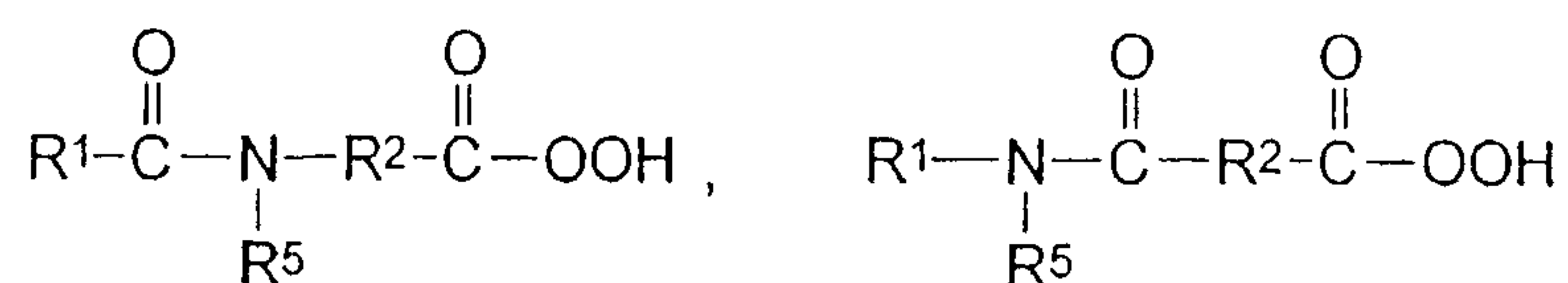
As noted hereinbefore, a preferred range of H.L.B. values (of the corresponding carboxylic acid) for the peroxyacids of the present invention (whether added directly or generated in situ) ranges from about 3.0 to about 6.5. A more preferred range of H.L.B. values (as the carboxylic acid) for the peroxyacids useful in the present invention (whether added directly or generated in situ) range from about 4.0 to 6.5. The most preferred range of H.L.B. values (as the carboxylic acid) for the peroxyacids of the present invention (whether added directly as generated in situ) ranges from about 4.0 to about 6.0.

(a) Peroxyacid

The present invention encompasses detergent compositions comprising an effective amount of the protease enzyme and a bleaching system comprising at least about 0.1%, preferably from about 0.1% to about 50%, by weight, of a substantially insoluble organic peroxyacid. The peroxyacid useful herein preferably comprises from about 0.5 to about 20, more preferably from about 1 to about 10, most preferably from about 2 to about 7, wt.% of the composition.

Preferred organic peroxyacids are selected from the group consisting of 4-nonylamino-4-oxoperoxybutyric acid; 6-(nonyl-amino)-6-oxoperoxyhexanoic acid; 1,12-diperoxydodecanedioic acid; heptyl sulfonylperpropionic acid; decylsulphonylperpropionic acid; and heptyl-, octyl-, nonyl-, decyl-sulphonylperbutyric acid; and mixtures thereof.

Of the organic peroxyacids, amidoperoxyacids (amide substituted peroxycarboxylic acids) are preferred. Suitable amidoperoxyacids for use herein are described in U.S. Patents 4,634,551 and 4,686,063, both Burns et al., issued January 6, 1987 and August 11, 1987, respectively. Suitable amidoperoxyacids are of the formula:



wherein R^1 is an alkyl, aryl, or alkaryl group containing from about 1 to about 14 carbon atoms (preferably R^1 is an alkyl group containing from about 6 to about 12 carbon atoms), R^2 is an alkylene, arylene or alkarylene group containing from about 1 to about 14 carbon atoms (preferably R^2 is an alkylene group containing from about 1 to about 6 carbon atoms), and R^5 is H or an alkyl, aryl, or alkaryl group containing from about 1 to about 10 carbon atoms (preferably R^5 is H). More preferably, R^1 is an alkyl group containing from about 8 to about 10 carbon atoms, and R^2 is an alkylene group containing from about 2 to about 4 carbon atoms.

Another preferred preformed peracid includes E-phthalimido-peroxycaproic acid ("PAP"). See for example U.S. Patent Nos. 5,487,818, 5,310,934, 5,246,620, 5,279,757 and 5,132,431.

Other suitable peroxycaproic acids include, but are not limited to, N,N'-terephthaloyl-di-(6-amino-peroxycaproic acid) ("TPCAP") and others described in U.S. Patent No. 5,770,551. Additionally, N-nonanoyl-6-amino peroxycaproic acid ("NAPCA") can also be used as a peracid. See U.S. Patent Nos. 5,523,434, 4,634,551 and 4,852,989.

Also suitable for use herein are peroxyfumarates, which are described in U.S. Patent 4,852,989, Burns et al., issued August 1, 1989, and sulfone peroxyacids (sulfone peroxycarboxylic acids), which are described in U.S. Patents 4,758,369, 4,824,591, and 5,004,558, all Dryoff et al., issued July 19, 1988, April 25, 1989, and April 2, 1991, respectively.

Example I of U.S. Patent 4,686,063 contains one description of the synthesis of NAPSA, from column 8, line 40 to column 9, line 5, and NAPAA, from column 9, line 15 to column 9, line 65. At the end of the amidoperoxyacid synthesis, the reaction is

quenched with water, filtered, washed with water to remove some excess sulfuric acid (or other strong acid with which the peroxyacid was made), and filtered again.

The amidoperoxyacid wet cake thus obtained can be contacted with a phosphate buffer solution at a pH between about 3.5 and 6, preferably between about 4 and 5, according to U.S. Patent 4,909,953, Sadlowski et al., issued March 20, 1990.

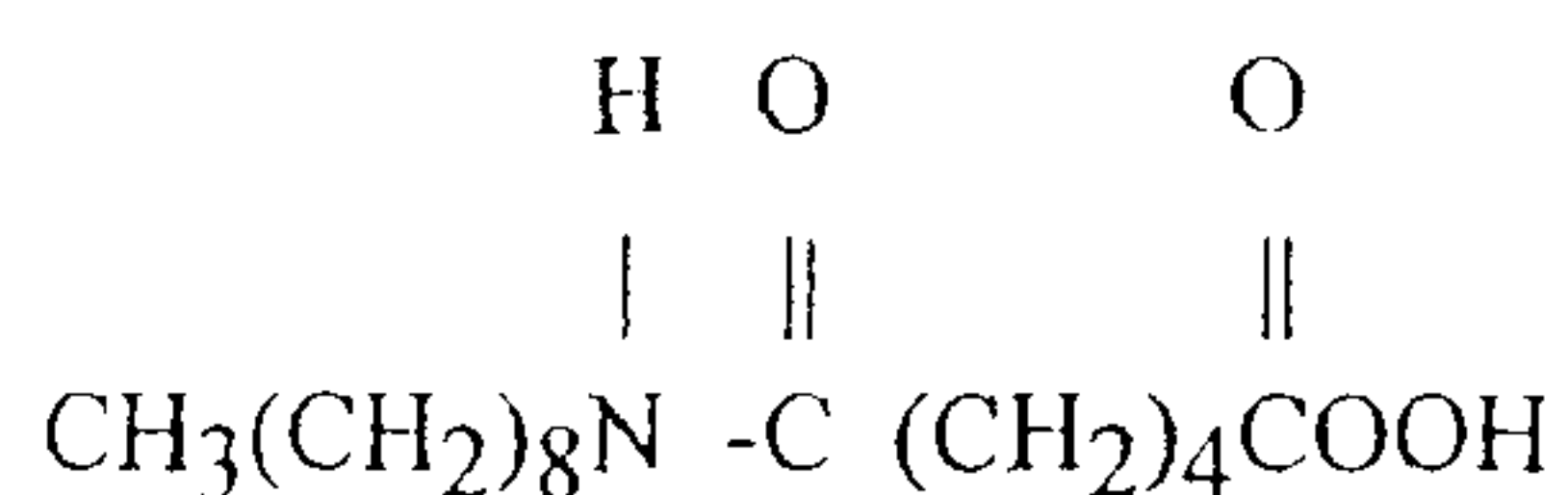
Other agents for storage stabilization or exotherm control can be added to the amidoperoxyacid before incorporation into the final product. For example, boric acid, an exotherm control agent disclosed in U.S. Patent 4,686,063, Burns, issued August 11, 1987 can be mixed with the amidoperoxyacid (which has been washed in phosphate buffer) in about a 2:1 peracid:boric acid ratio. The phosphate buffer washed amidoperoxyacid can also be mixed with appropriate amounts of dipicolinic acid and tetrasodium pyrophosphate, a chelating stabilization system. Chelants can optionally be included in the phosphate buffer before contact with the wet cake.

The wet cake is preferably made up of particles with an average particle diameter of from about 0.1 to about 260 microns, preferably from about 10 to about 100 microns, and most preferably from about 30 to about 60 microns. Small particle size NAPAA crystals are desired herein. See U.S. Patent 5,055,218, Getty et al., issued October 8, 1991.

NAPAA filter cake herein is preferably washed twice in phosphate buffer. It has been found that two successive phosphate buffer washes lend optimal stability to NAPAA.

Particulate (solid), organic peroxyacids with a theoretical AvO (available oxygen) of between about 3 and about 12, most preferably between 5 and 7, are preferred.

Most preferred for use herein is NAPAA. Another name for the nonylamide of peroxyadipic acid ("NAPAA") is 6-(nonylamino)-6-oxoperoxycaproic acid. The chemical formula for NAPAA is:



The molecular weight of NAPAA is 287.4.

Detergent compositions and bleaching compositions containing NAPAA provide extremely effective and efficient surface bleaching of textiles. Stains and/or soils are removed from the textiles. These compositions are particularly effective at removing dingy soils from textiles.

NAPAA's polar amide or substituted amide moiety results in a peroxyacid which has a very low vapor pressure and thus possesses a low odor profile as well as excellent bleaching performance. It is believed that the polarity of the amide group results in a reduction of vapor pressure of the peroxyacid, and an increase in melting point.

NAPAA can be used directly as a bleaching agent. It has a reduced vapor pressure and a good odor profile in laundry applications.

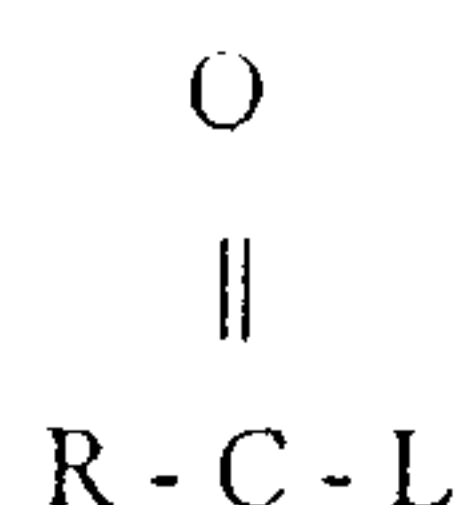
NAPAA can be prepared by, for example, first reacting NAAA (monononyl amide of adipic acid), sulfuric acid, and hydrogen peroxide. The reaction product is quenched by addition to ice water followed by filtration, washing with distilled water, and final suction filtration to recover the wet cake. Washing can be continued until the pH of the filtrate is neutral.

It is also preferred that the NAPAA pH (10% solids in water) be between about 4.2 and 4.8. Surprisingly, this pH results in more thermally stable particles.

(b) Bleaching Systems - Bleach Activator and Peroxygen Bleaching Compound

(i) Bleach Activators

The bleach activator for the bleaching systems useful herein preferably has the following structure:

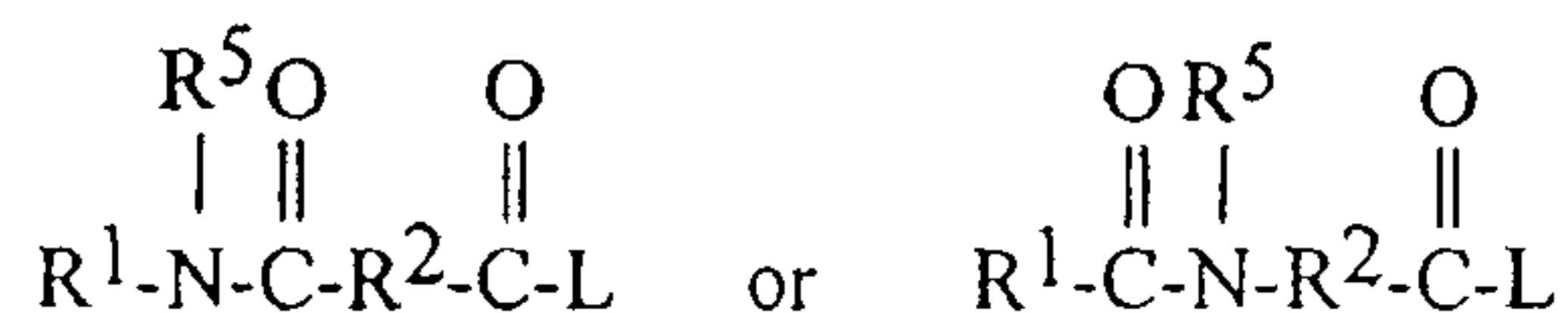


wherein R is an alkyl group containing from about 5 to about 18 carbon atoms wherein the longest linear alkyl chain extending from and including the carbonyl carbon contains from about 6 to about 10 carbon atoms and L is a leaving group, the conjugate acid of which has a pKa in the range of from about 4 to about 13, preferably from about 6 to about 11, most preferably from about 8 to about 11.

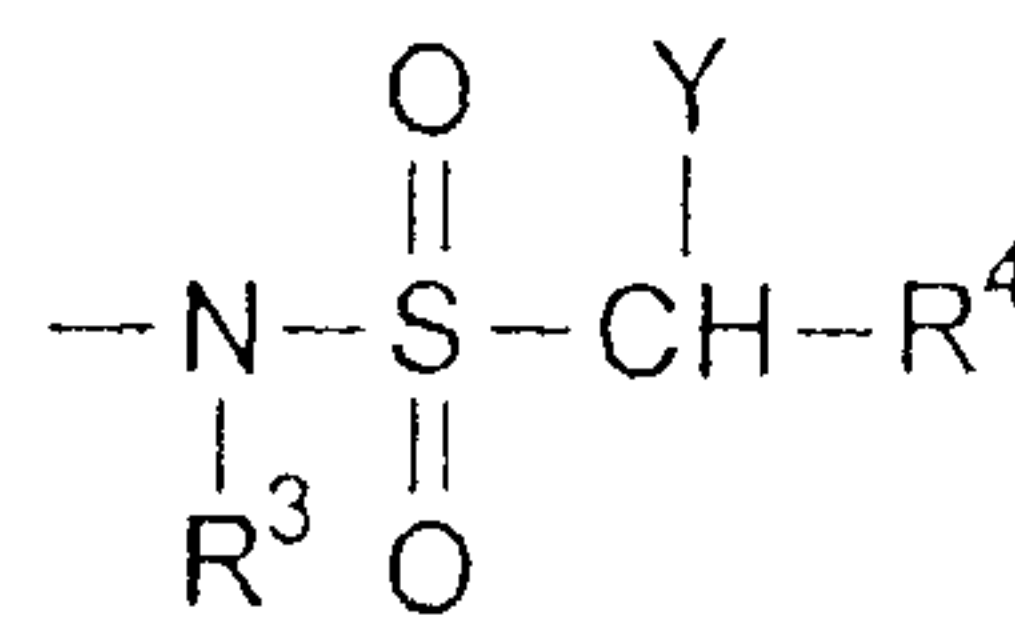
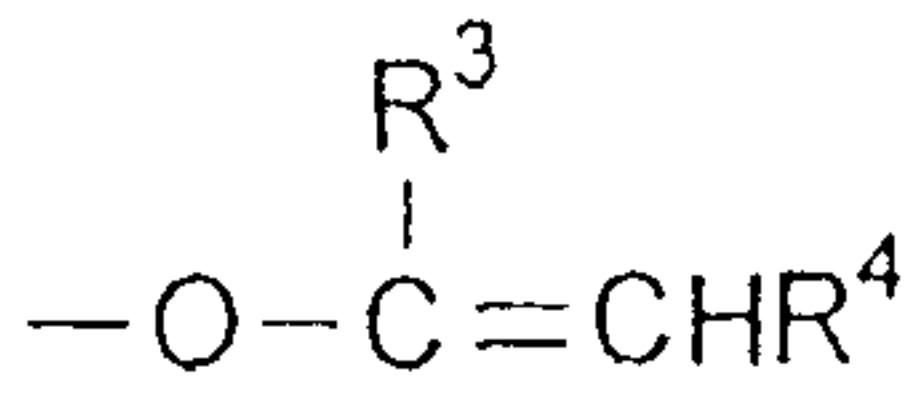
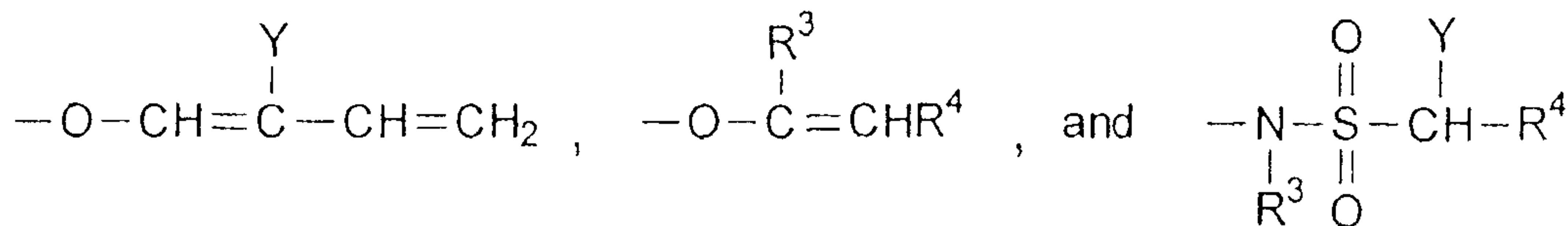
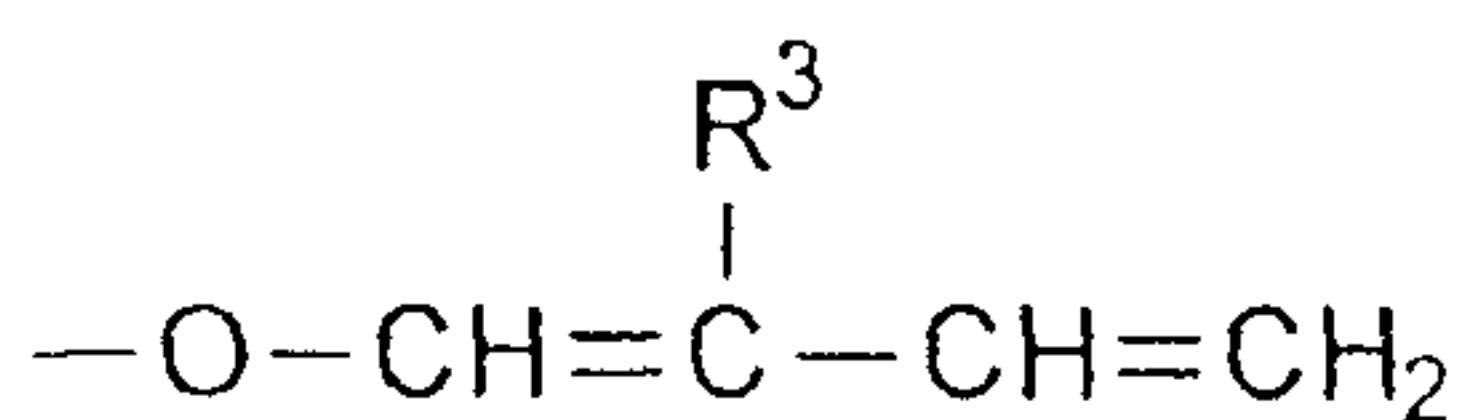
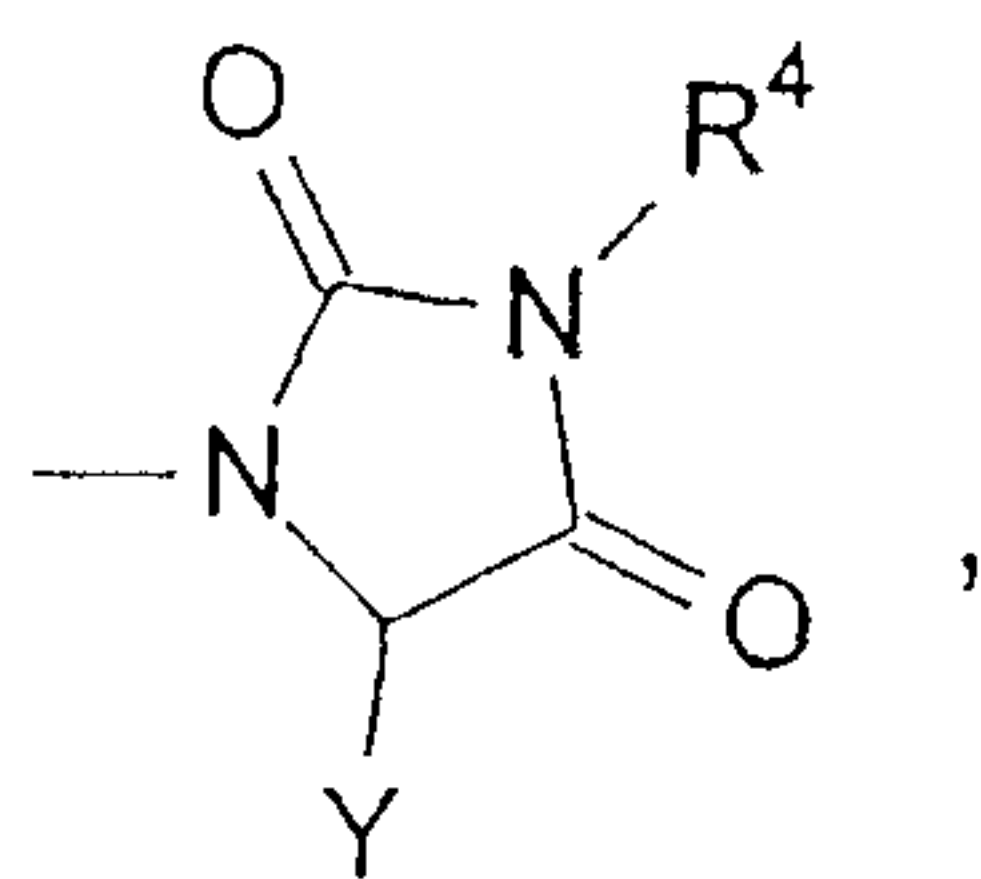
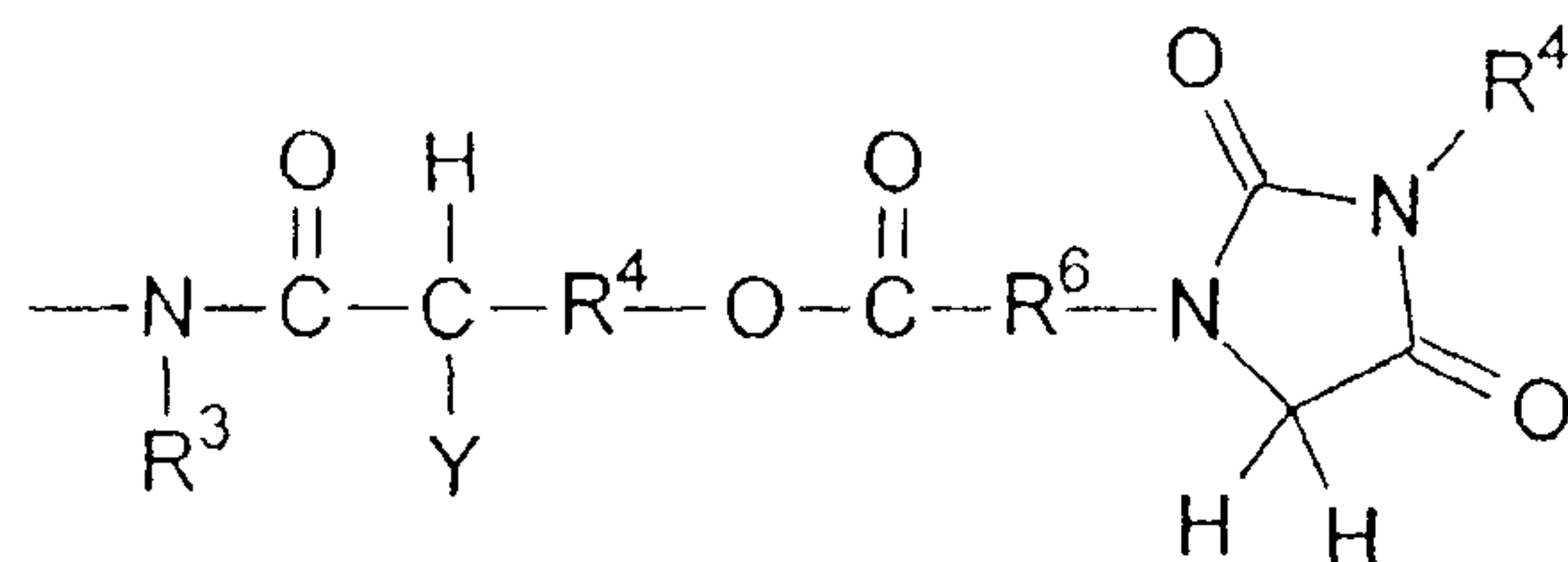
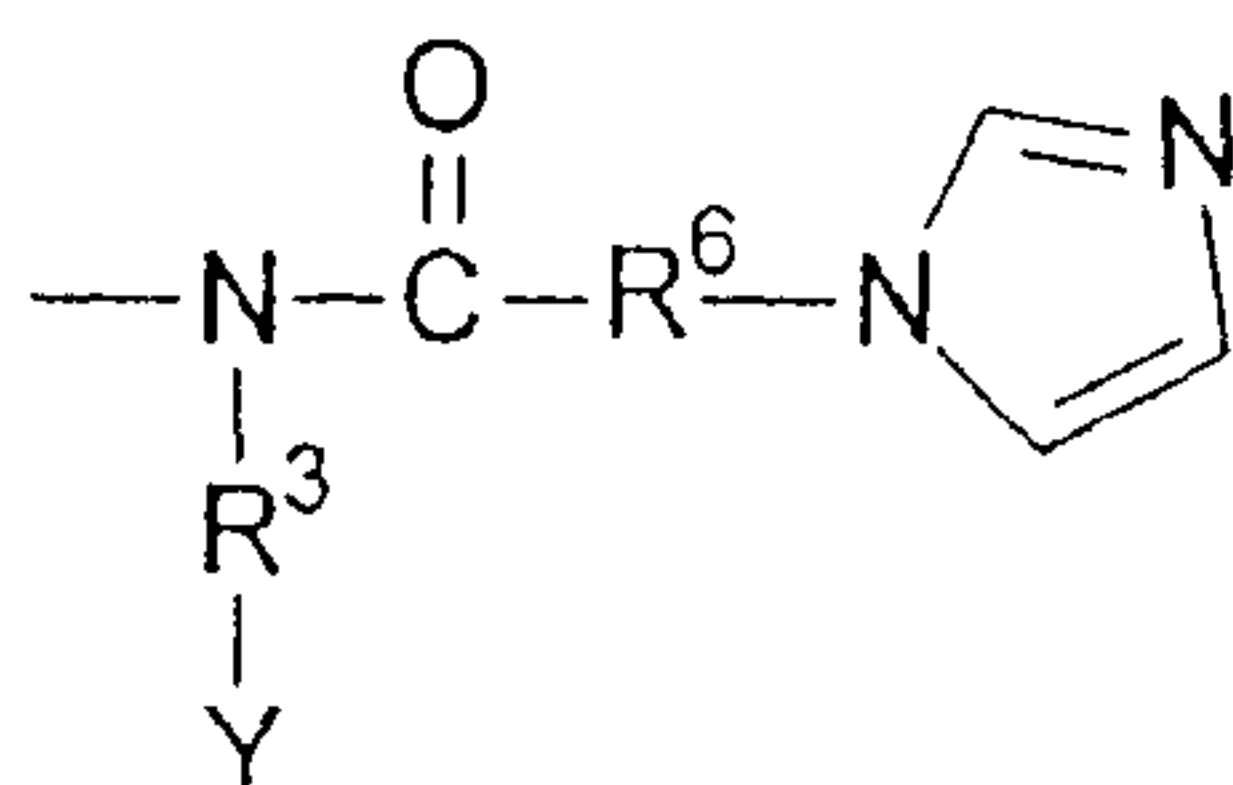
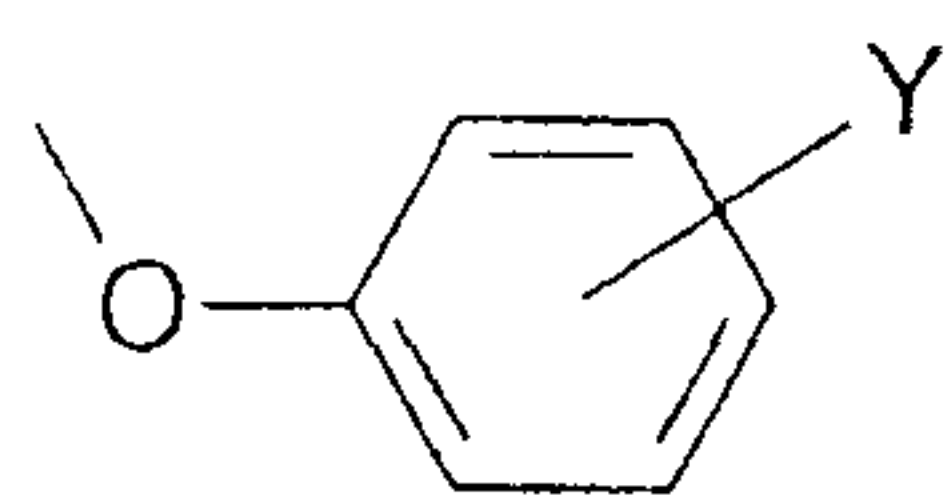
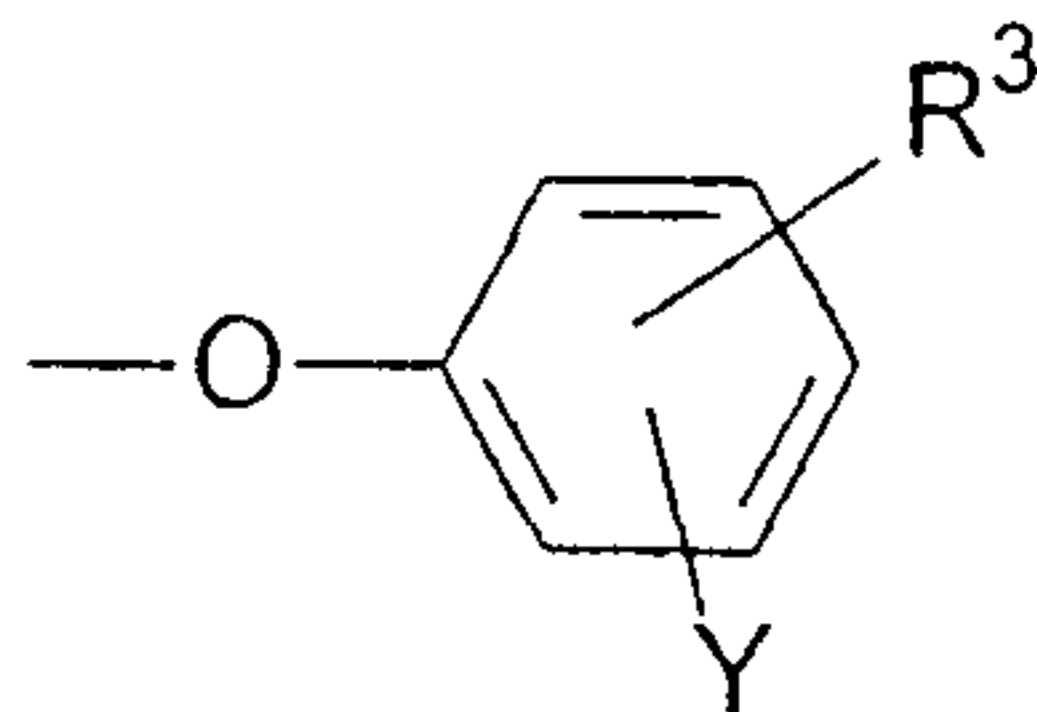
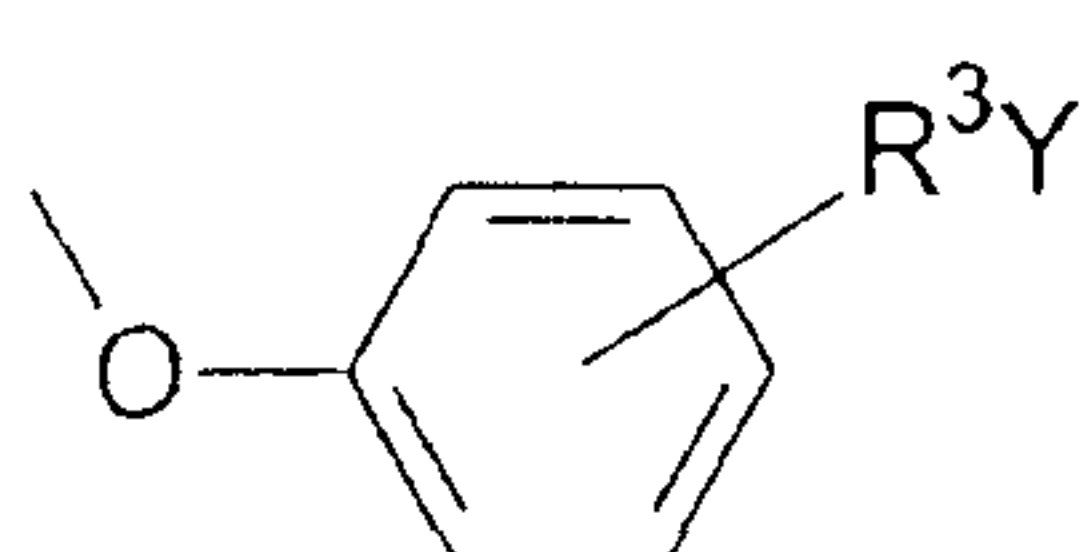
L can be essentially any suitable leaving group. A leaving group is any group that is displaced from the bleach activator as a consequence of the nucleophilic attack on the bleach activator by the perhydroxide anion. This, the perhydrolysis reaction, results in the formation of the percarboxylic acid. Generally, for a group to be a suitable leaving group it must exert an electron attracting effect. This facilitates the nucleophilic attack by the perhydroxide anion.

The L group must be sufficiently reactive for the reaction to occur within the optimum time frame (e.g., a wash cycle). However, if L is too reactive, this activator will be difficult to stabilize. These characteristics are generally paralleled by the pKa of the conjugate acid of the leaving group, although exceptions to this convention are known.

Preferred bleach activators are those of the general formula:



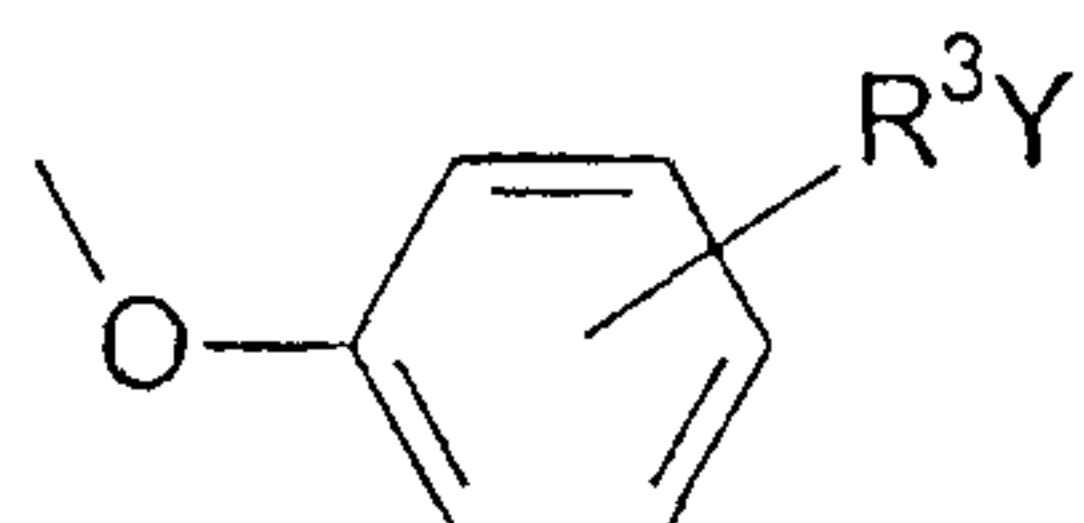
wherein R^1 is an alkyl group containing from about 6 to about 12 carbon atoms, R^2 is an alkylene containing from 1 to about 6 carbon atoms, R^5 is H or alkyl, aryl, or alkaryl containing from about 1 to about 10 carbon atoms, and L is selected from the group consisting of:



wherein R^6 is an alkylene, arylene, or alkarylene group containing from about 1 to about 14 carbon atoms, R^3 is an alkyl chain containing from about 1 to about 8 carbon atoms, R^4 is H or R^3 , and Y is H or a solubilizing group. Y is preferably selected from the group consisting of $-\text{SO}_3\text{-M}^+$, $-\text{COO-M}^+$, $-\text{SO}_4\text{-M}^+$, $(-\text{N}^+\text{R}'_3)\text{X}^-$ and $\text{O}^-\text{N(R}'_3)$,

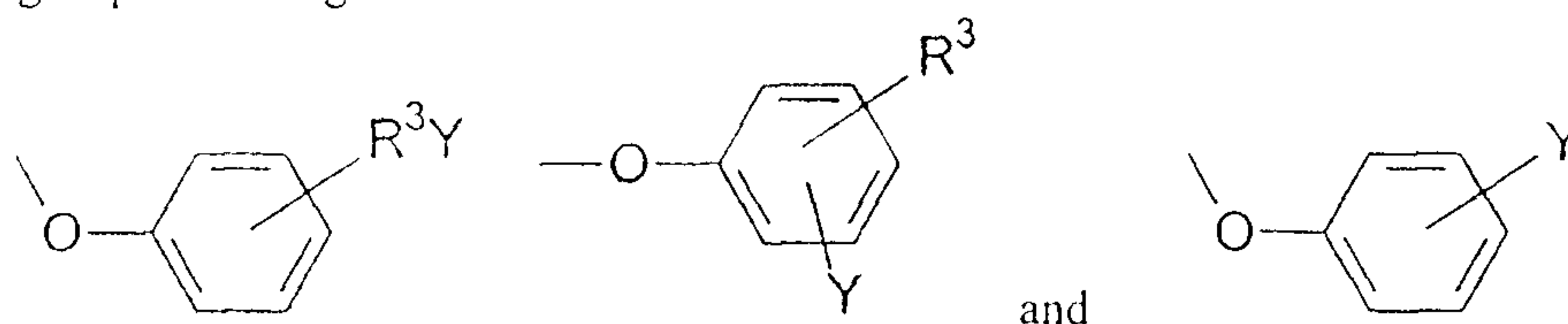
wherein R' is an alkyl chain containing from about 1 to about 4 carbon atoms, M is a cation which provides solubility to the bleach activator and X is an anion which provides

solubility to the bleach activator. Preferably, M is an alkali metal, ammonium or substituted ammonium cation, with sodium and potassium being most preferred, and X is an anion selected from the group consisting of halide, hydroxide, methylsulfate and acetate anions. More preferably, Y is $-\text{SO}_3\text{-M}^+$ and $-\text{COO-M}^+$. It should be noted that bleach activators with a leaving group that does not contain a solubilizing group should be well dispersed in the bleach solution in order to assist in their dissolution. Preferred is:



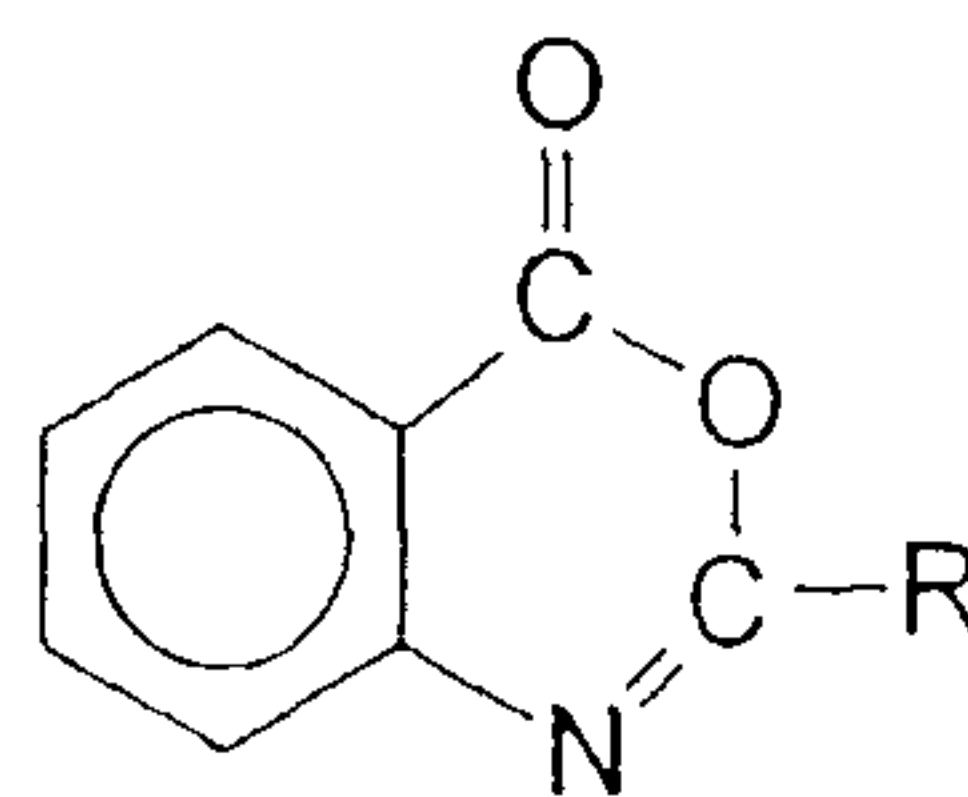
wherein R^3 is as defined above and Y is $-\text{SO}_3\text{-M}^+$ or $-\text{COO-M}^+$ wherein M is as defined above.

Especially preferred bleach activators are those wherein R^1 is a linear alkyl chain containing from about 6 to about 12 carbon atoms, R^2 is a linear alkylene chain containing from about 2 to about 6 carbon atoms, R^5 is H, and L is selected from the group consisting of:



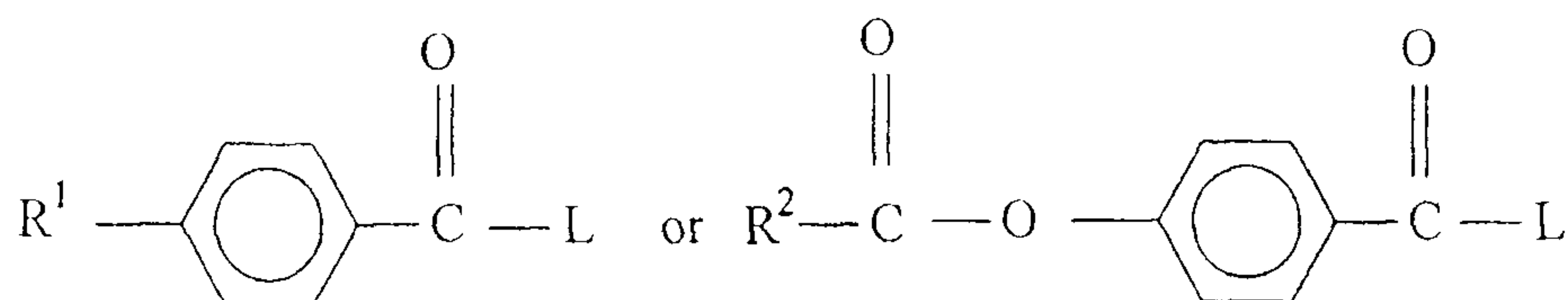
wherein R^3 is as defined above, Y is $-\text{SO}_3\text{-M}^+$ or $-\text{COO-M}^+$ and M is as defined above.

A preferred bleach activator is:



wherein R is H, alkyl, aryl or alkaryl. This is described in U.S. Patent 4,966,723, Hodge et al.

Preferred bleach activators are:

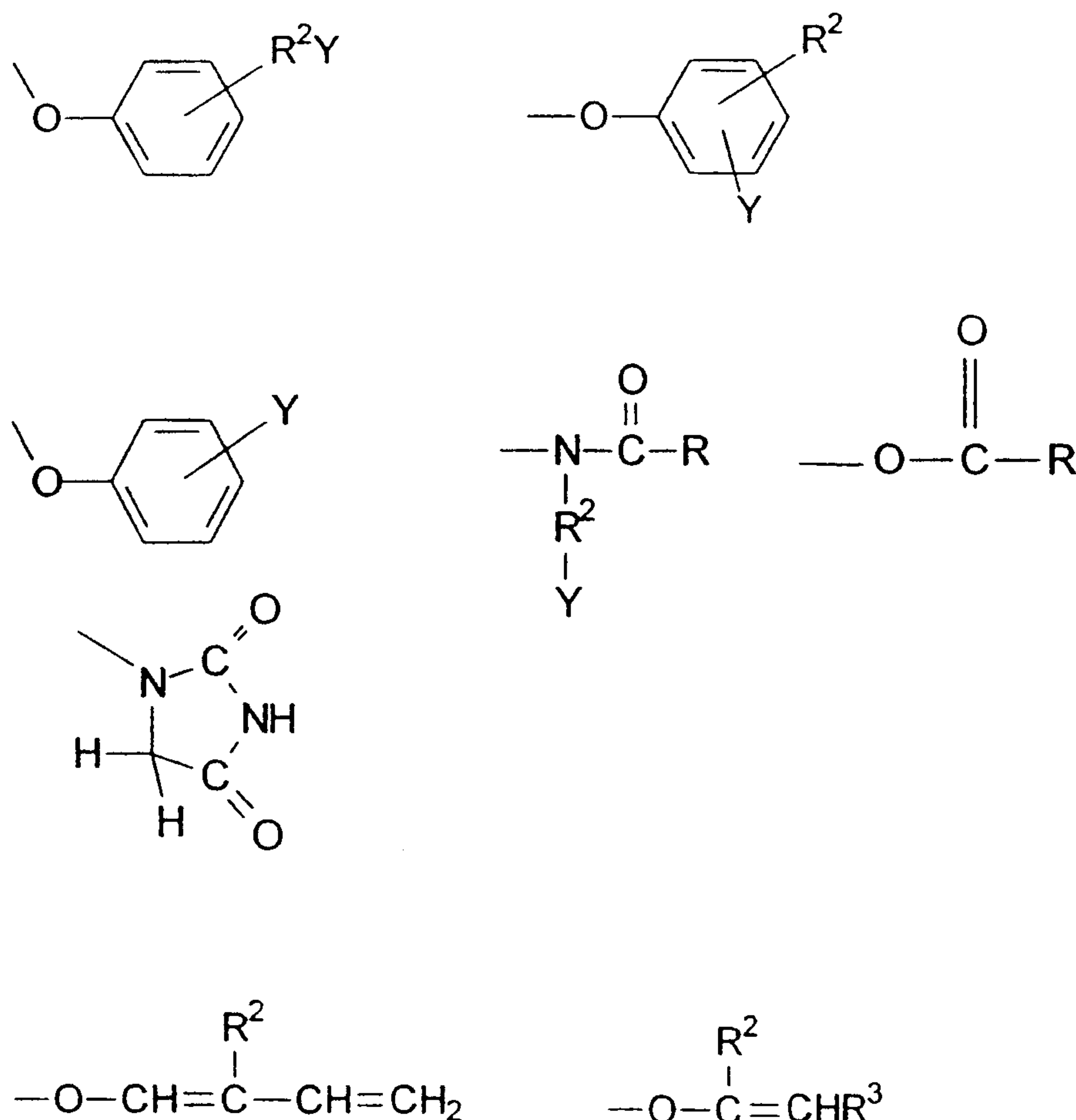


wherein R^1 is H or an alkyl group containing from about 1 to about 6 carbon atoms and R^2 is an alkyl group containing from about 1 to about 6 carbon atoms and L is as defined above.

Preferred bleach activators are also those of the above general formula wherein L is as defined in the general formula, and R^1 is H or an alkyl group containing from about 1 to about 4 carbon atoms.

Even more preferred are bleach activators of the above general formula wherein L is as defined in the general formula and R^1 is a H.

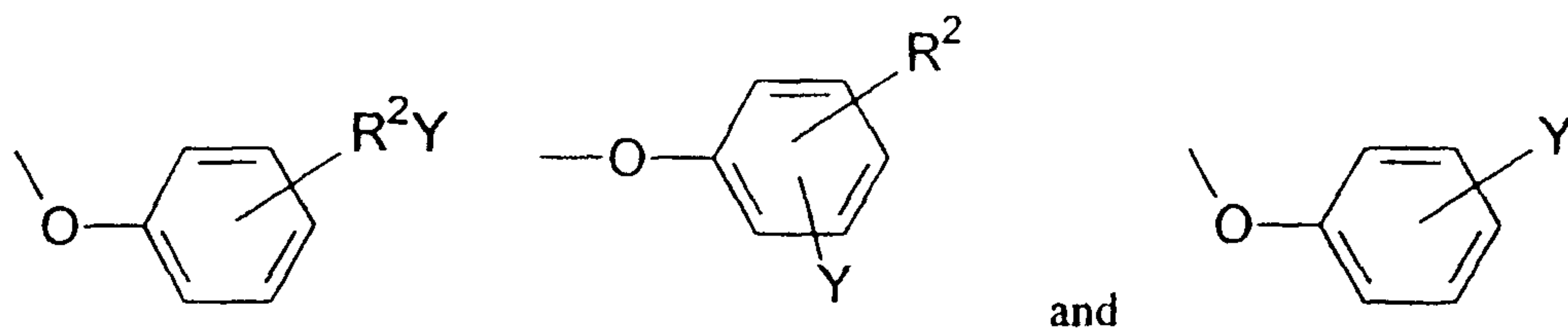
More preferred bleach activators are those of the above general formula wherein R is a linear alkyl chain containing from about 5 to about 9 and preferably from about 6 to about 8 carbon atoms and L is selected from the group consisting of:



wherein R, R^2 , R^3 and Y are as defined above.

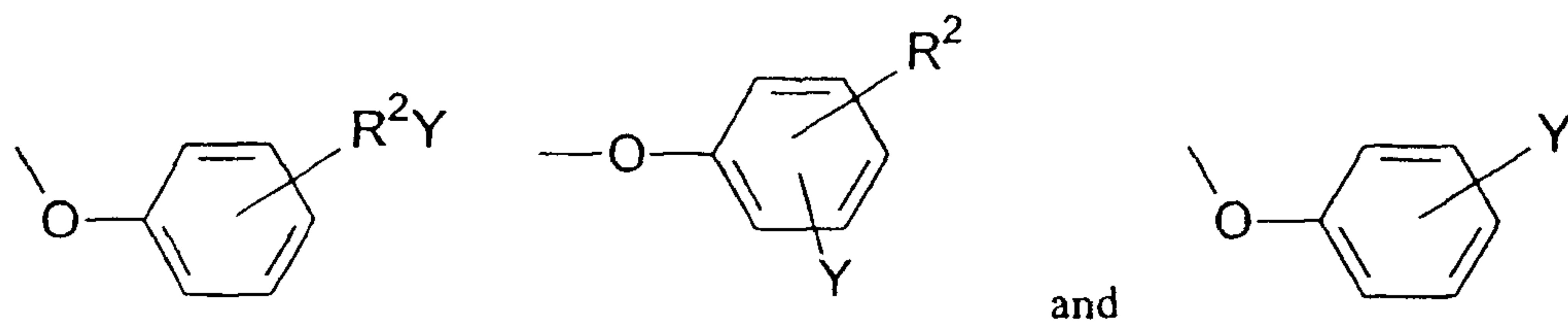
Particularly preferred bleach activators are those of the above general formula wherein R is an alkyl group containing from about 5 to about 12 carbon atoms wherein the longest linear portion of the alkyl chain extending from and including the carbonyl

carbon is from about 6 to about 10 carbon atoms, and L is selected from the group consisting of:



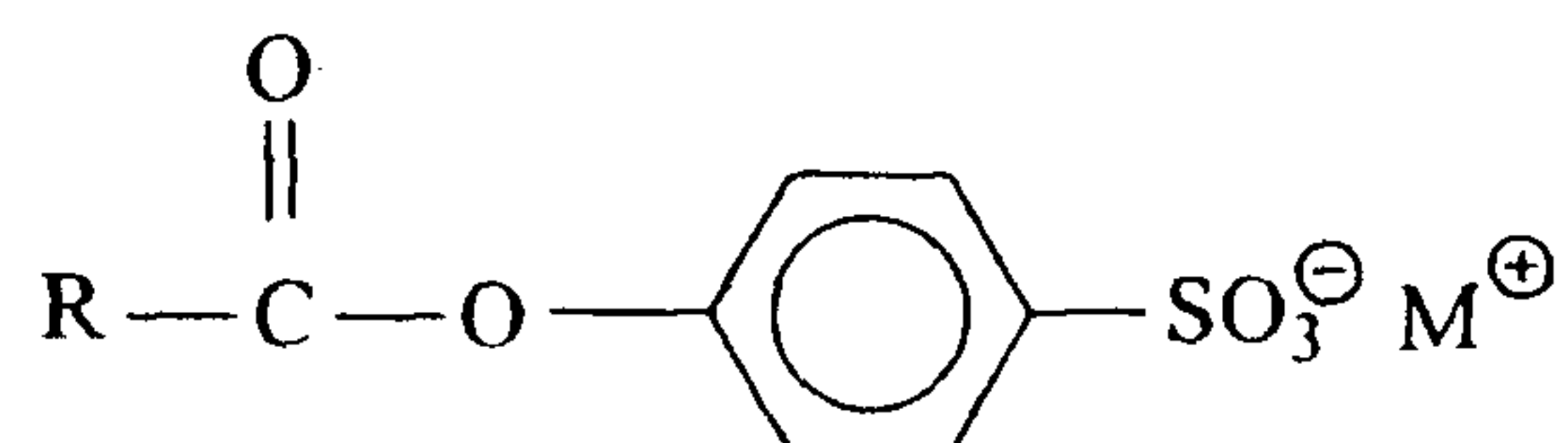
wherein R^2 is an alkyl chain containing from about 1 to about 8 carbon atoms, and Y is $-SO_3M^+$ or $-COO-M^+$ wherein M is an alkali metal, ammonium or substituted ammonium cation.

Especially preferred bleach activators are those of the above general formula wherein R is a linear alkyl chain containing from about 5 to about 9 and preferably from about 6 to about 8 carbon atoms and L is selected from the group consisting of:



wherein R^2 is as defined above and Y is $-SO_3M^+$ or $-COO-M^+$ wherein M is as defined above.

The most preferred bleach activators have the formula:

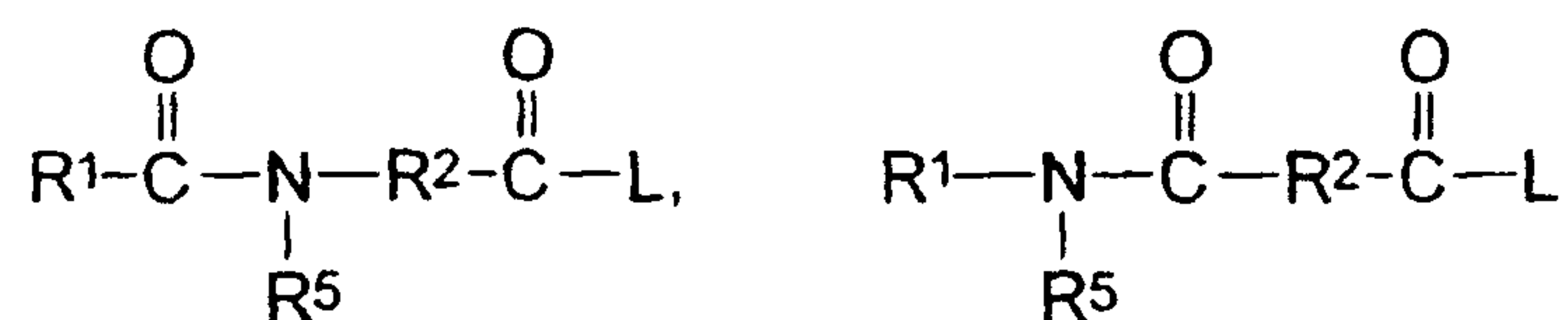


wherein R is a linear alkyl chain containing from about 5 to about 9 and preferably from about 6 to about 8 carbon atoms and M is sodium or potassium.

Preferably, the bleach activator herein is sodium nonanoyloxybenzenesulfonate (NOBS) or sodium benzoyloxybenzenesulfonate (BOBS).

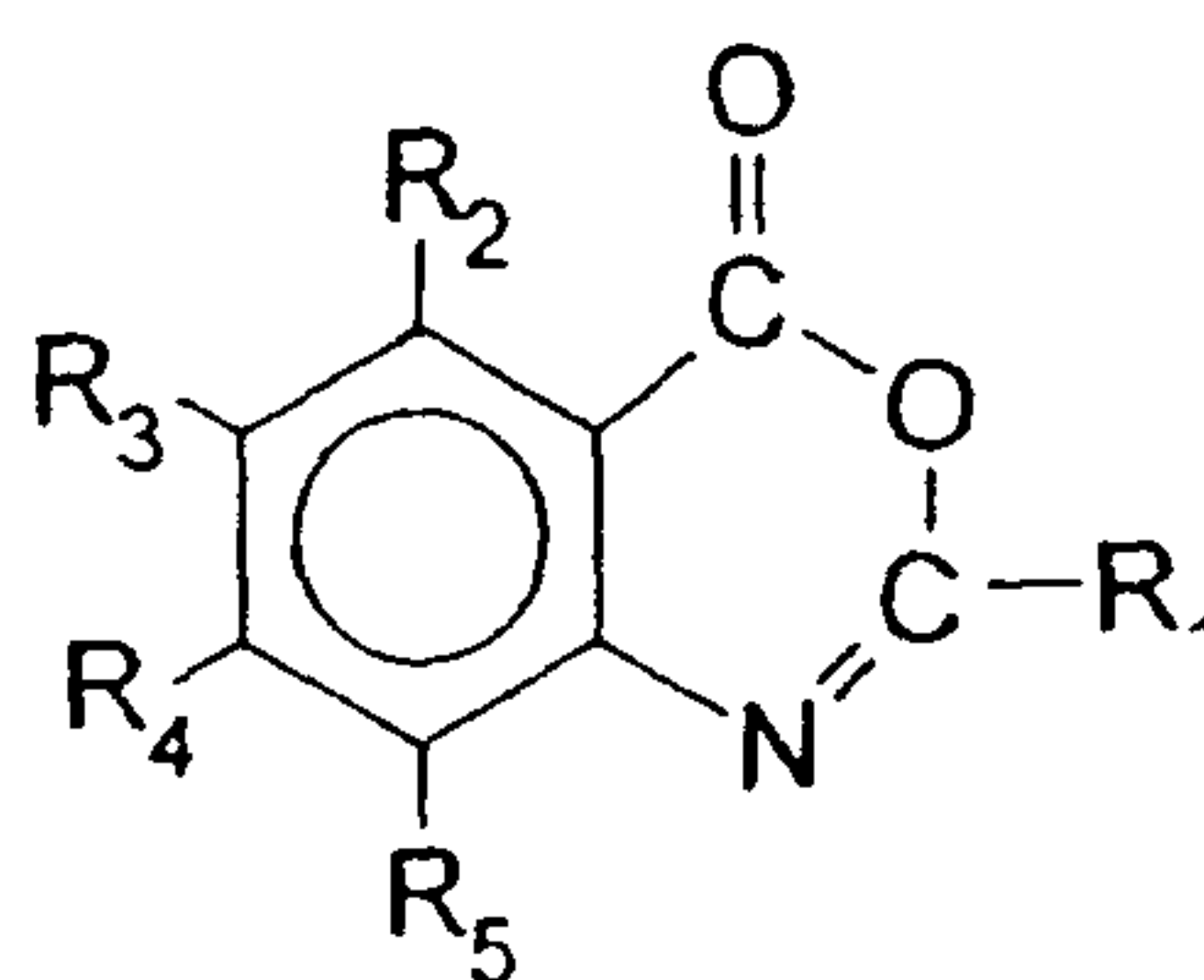
Further particularly preferred for use in the present invention bleaching compositions are the following bleach activators which are particularly safe for use with machines having natural rubber parts. This is believed to be the result of not producing oily diacylperoxide (DAP) species by the perhydrolysis reaction of these amido acid-derived bleach activators, but rather forming insoluble crystalline solid DAP's. These solids are believed to not form a coating film and thus natural rubber parts are not exposed to DAP's for extended periods of time. These preferred bleach activators are members selected from the group consisting of:

- a) a bleach activator of the general formula:



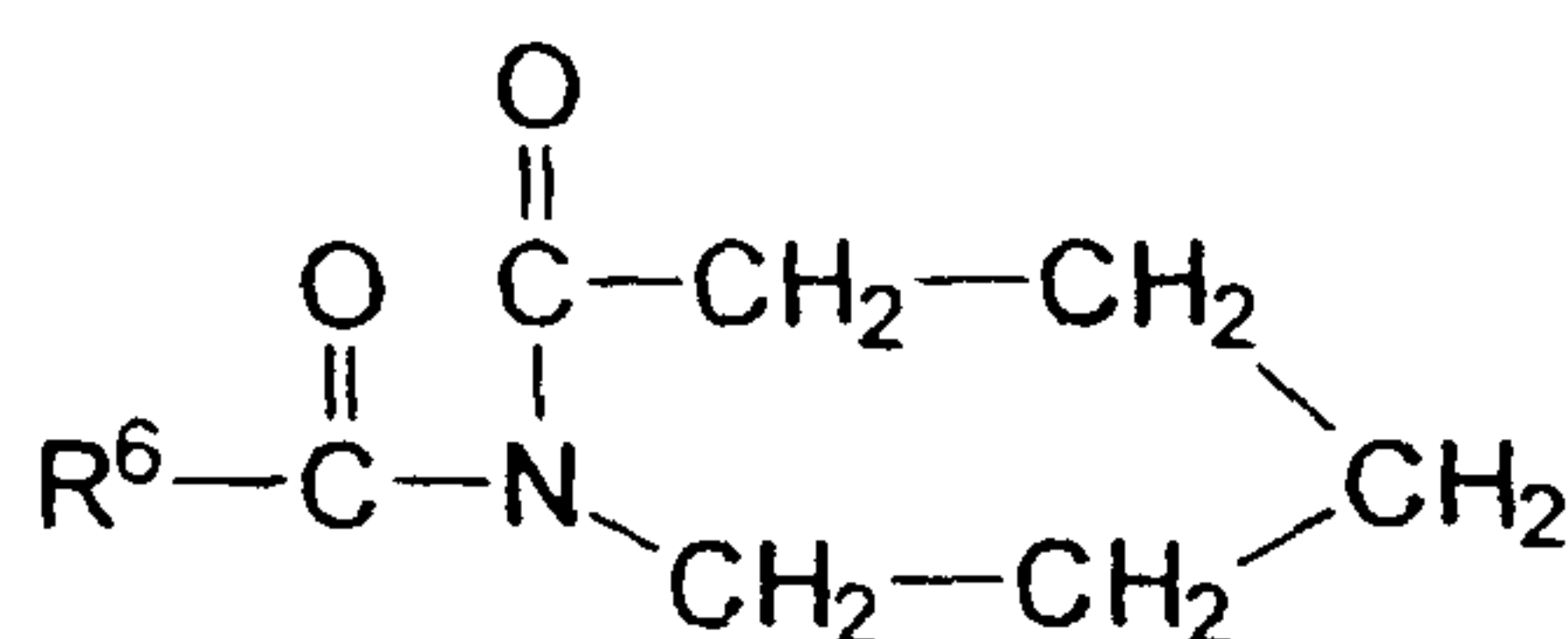
or mixtures thereof, wherein R^1 is an alkyl, aryl, or alkaryl group containing from about 1 to about 14 carbon atoms, R^2 is an alkylene, arylene or alkarylene group containing from about 1 to about 14 carbon atoms, R^5 is H or an alkyl, aryl, or alkaryl group containing from about 1 to about 10 carbon atoms, and L is a leaving group;

- b) benzoxazin-type bleach activators of the general formula:



wherein R_1 is H, alkyl, alkaryl, aryl, arylalkyl, and wherein R_2 , R_3 , R_4 , and R_5 may be the same or different substituents selected from H, halogen, alkyl, alkenyl, aryl, hydroxyl, alkoxyl, amino, alkylamino, COOR_6 (wherein R_6 is H or an alkyl group) and carbonyl functions;

- c) N-acyl caprolactam bleach activators of the formula:



wherein R^6 is H or an alkyl, aryl, alkoxyaryl or alkaryl group containing from 1 to 12 carbons; and

- d) mixtures of a), b) and c).

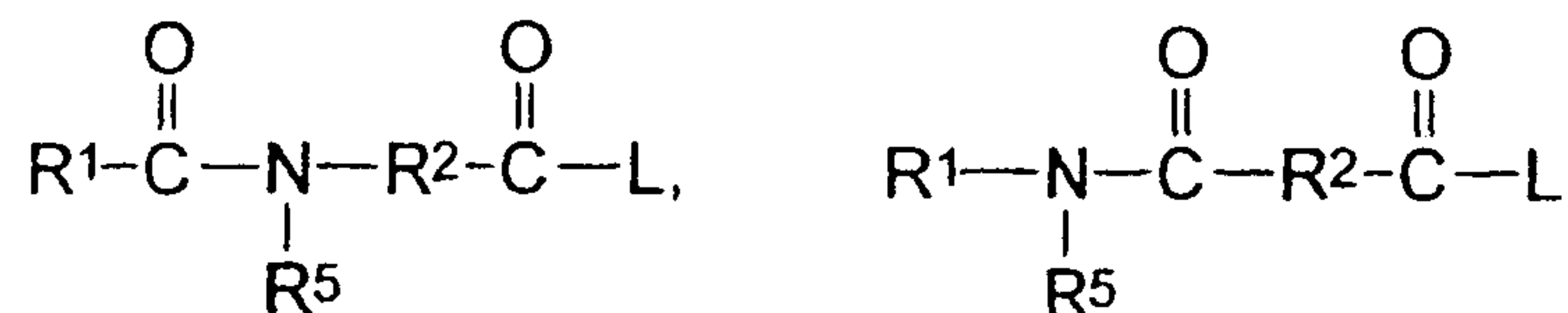
Preferred bleach activators of type a) are those wherein R^1 is an alkyl group containing from about 6 to about 12 carbon atoms, R^2 contains from about 1 to about 8 carbon atoms, and R^5 is H or methyl. Particularly preferred bleach activators are those of the above general formulas wherein R^1 is an alkyl group containing from about 7 to about 10 carbon atoms and R^2 contains from about 4 to about 5 carbon atoms.

Preferred bleach activators of type b) are those wherein R_2 , R_3 , R_4 , and R_5 are H and R_1 is a phenyl group.

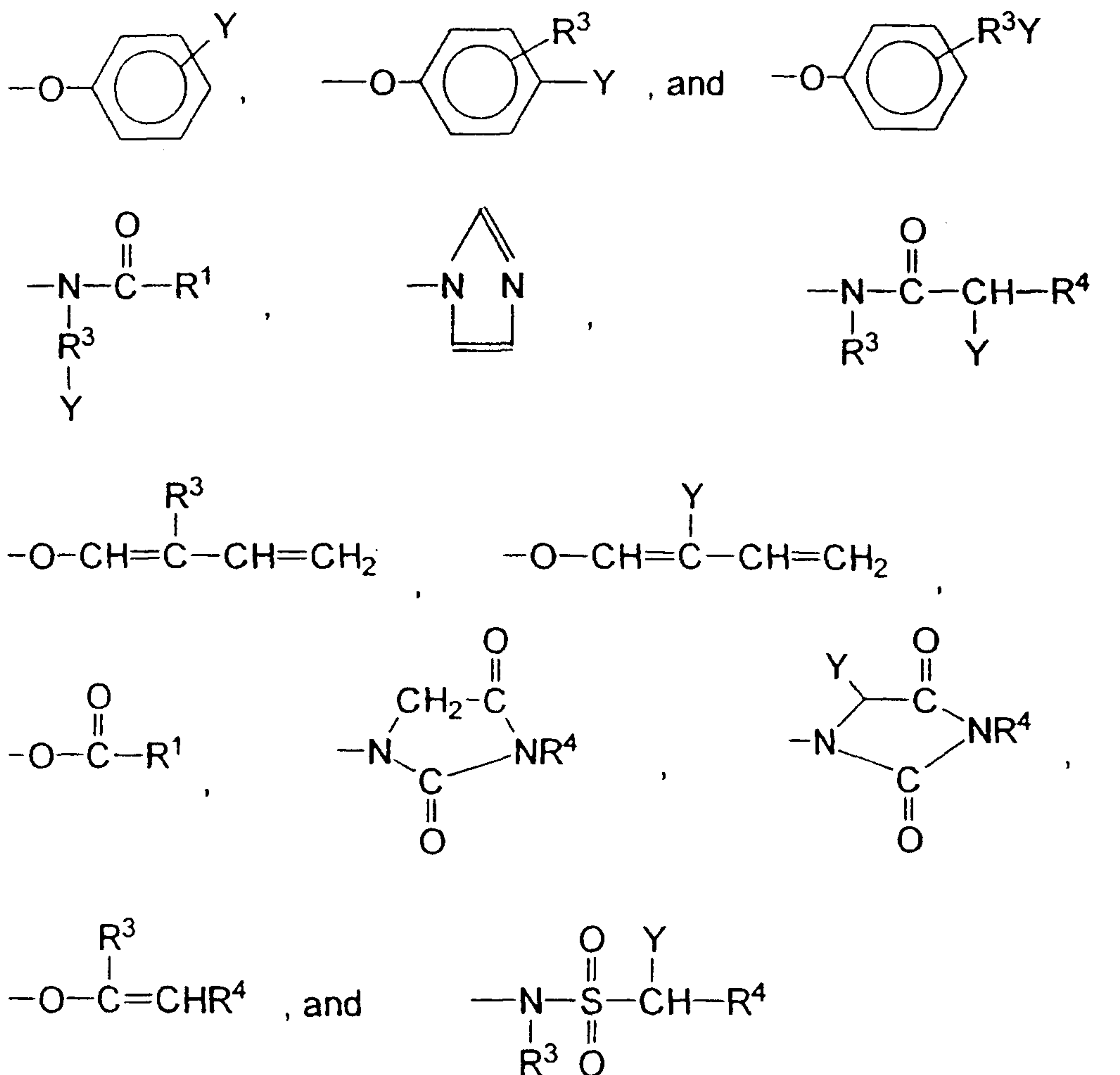
The preferred acyl moieties of said N-acyl caprolactam bleach activators of type c) have the formula $\text{R}^6-\text{CO}-$ wherein R^6 is H or an alkyl, aryl, alkoxyaryl, or alkaryl

group containing from 1 to 12 carbons, preferably from 6 to 12 carbon atoms. In highly preferred embodiments, R^6 is a member selected from the group consisting of phenyl, heptyl, octyl, nonyl, 2,4,4-trimethylpentyl, decenyl and mixtures thereof.

- Amido Derived Bleach Activators - The bleach activators of type a) employed in the present invention are amide substituted compounds of the general formulas:



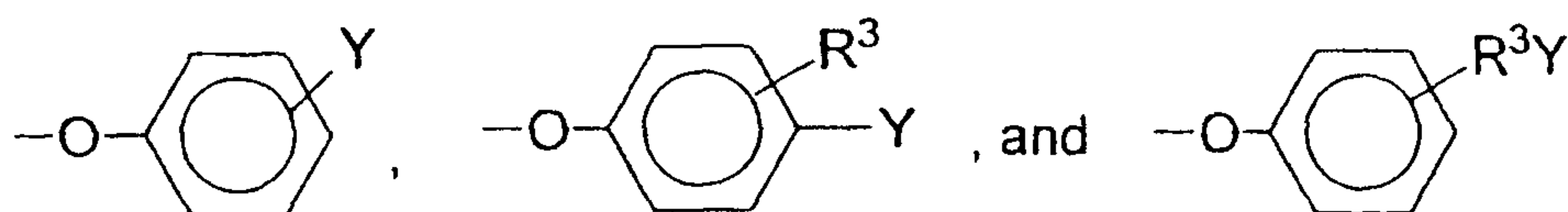
or mixtures thereof, wherein R^1 , R^2 and R^5 are as defined above and L can be essentially any suitable leaving group. Preferred bleach activators are those of the above general formula wherein R^1 , R^2 and R^5 are as defined for the peroxyacid and L is selected from the group consisting of:



and mixtures thereof, wherein R^1 is an alkyl, aryl, or alkaryl group containing from about 1 to about 14 carbon atoms, R^3 is an alkyl chain containing from 1 to about 8 carbon atoms, R^4 is H or R^3 , and Y is H or a solubilizing group.

The preferred solubilizing groups are $-\text{SO}_3^- \text{M}^+$, $-\text{CO}_2^- \text{M}^+$, $-\text{SO}_4^- \text{M}^+$, $-\text{N}^+(\text{R}^3)_4 \text{X}^-$ and $\text{O} < \text{N}(\text{R}^3)_3$ and most preferably $-\text{SO}_3^- \text{M}^+$ and $-\text{CO}_2^- \text{M}^+$ wherein R^3 is an alkyl chain containing from about 1 to about 4 carbon atoms, M is a cation which provides solubility to the bleach activator and X is an anion which provides solubility to the bleach activator. Preferably, M is an alkali metal, ammonium or substituted ammonium cation, with sodium and potassium being most preferred, and X is a halide, hydroxide, methylsulfate or acetate anion. It should be noted that bleach activators with a leaving group that does not contain a solubilizing groups should be well dispersed in the bleaching solution in order to assist in their dissolution.

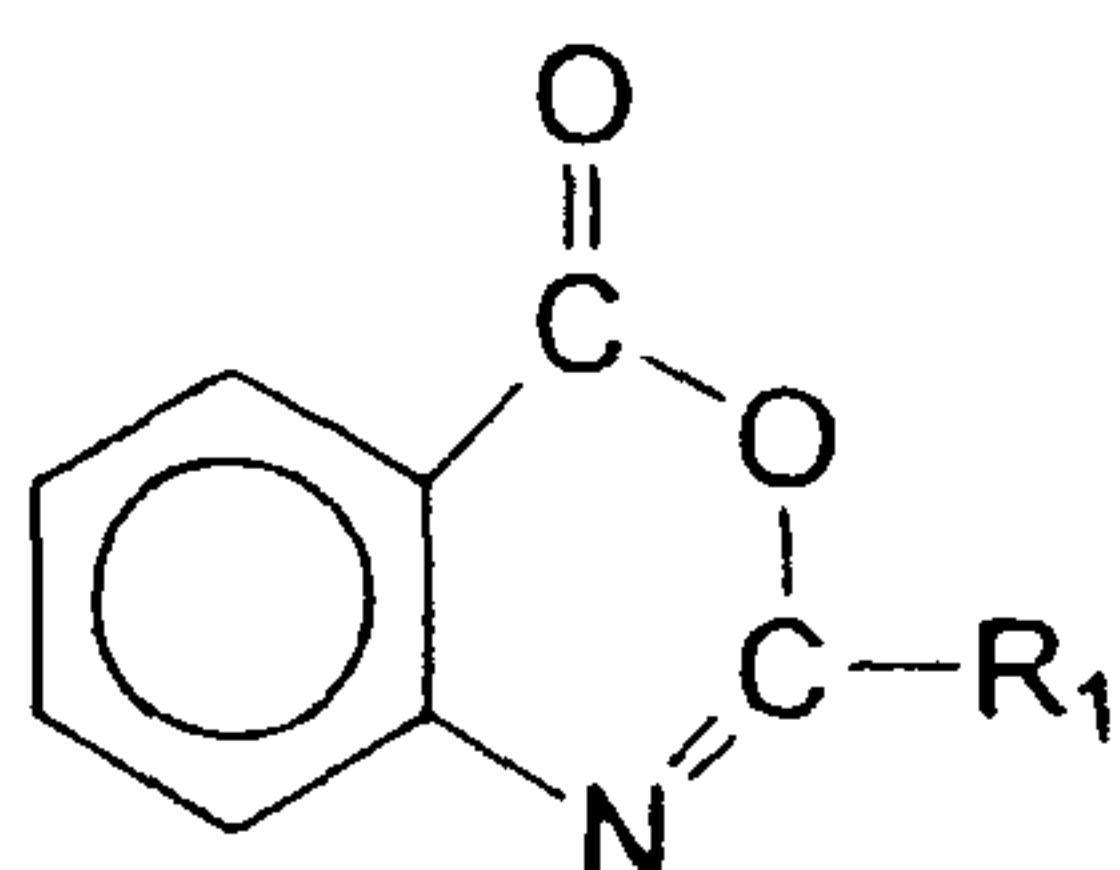
Preferred bleach activators are those of the above general formula wherein L is selected from the group consisting of:



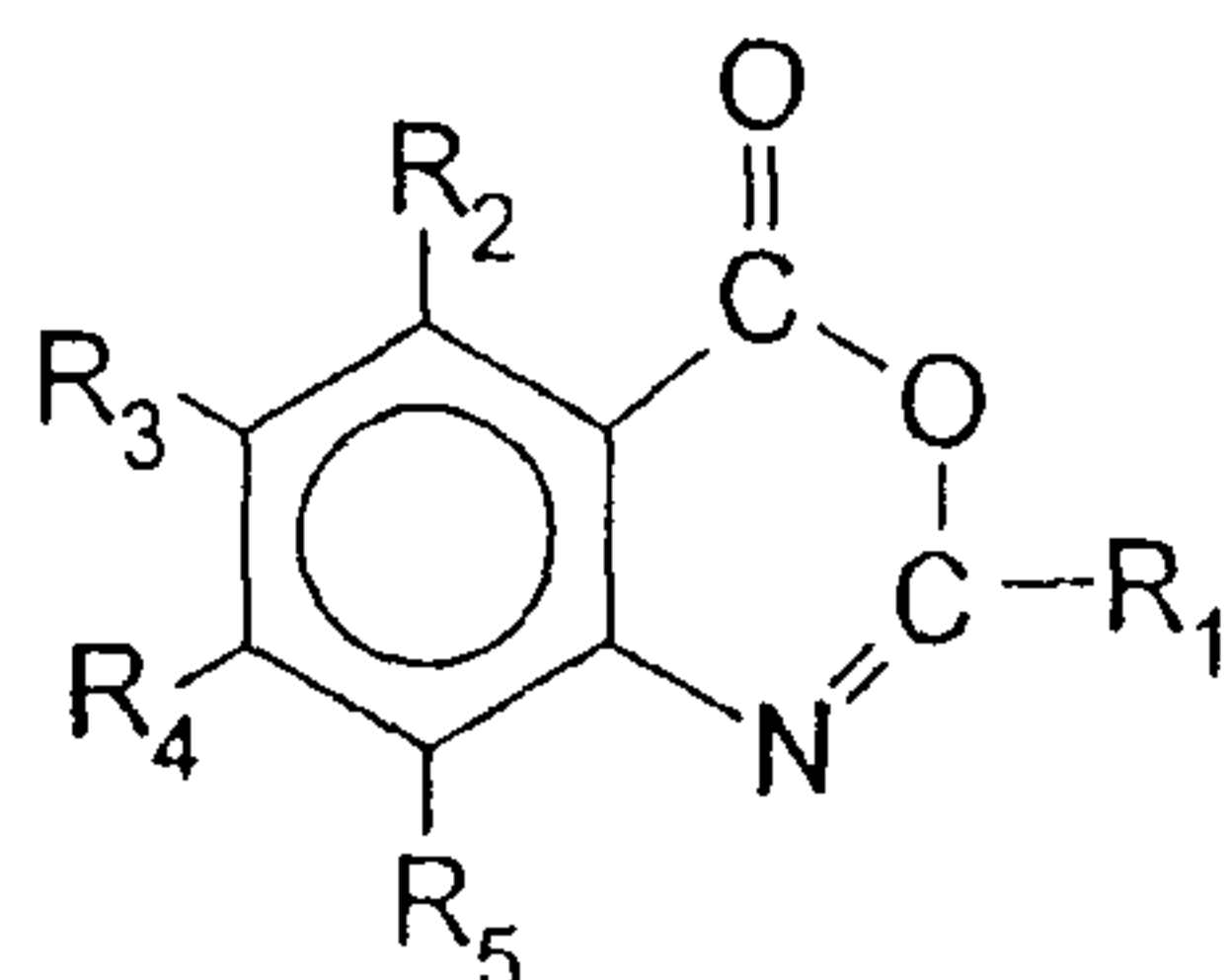
wherein R^3 is as defined above and Y is $-\text{SO}_3^- \text{M}^+$ or $-\text{CO}_2^- \text{M}^+$ wherein M is as defined above.

Another important class of bleach activators, including those of type b) and type c), provide organic peracids as described herein by ring-opening as a consequence of the nucleophilic attack on the carbonyl carbon of the cyclic ring by the perhydroxide anion. For instance, this ring-opening reaction in type c) activators involves attack at the caprolactam ring carbonyl by hydrogen peroxide or its anion. Since attack of an acyl caprolactam by hydrogen peroxide or its anion occurs preferably at the exocyclic carbonyl, obtaining a significant fraction of ring-opening may require a catalyst. Another example of ring-opening bleach activators can be found in type b) activators, such as those disclosed in U.S. Patent 4,966,723, Hodge et al, issued Oct. 30, 1990.

- Benzoxazin-type Bleach Activators - Such activator compounds disclosed by Hodge include the activators of the benzoxazin-type, having the formula:

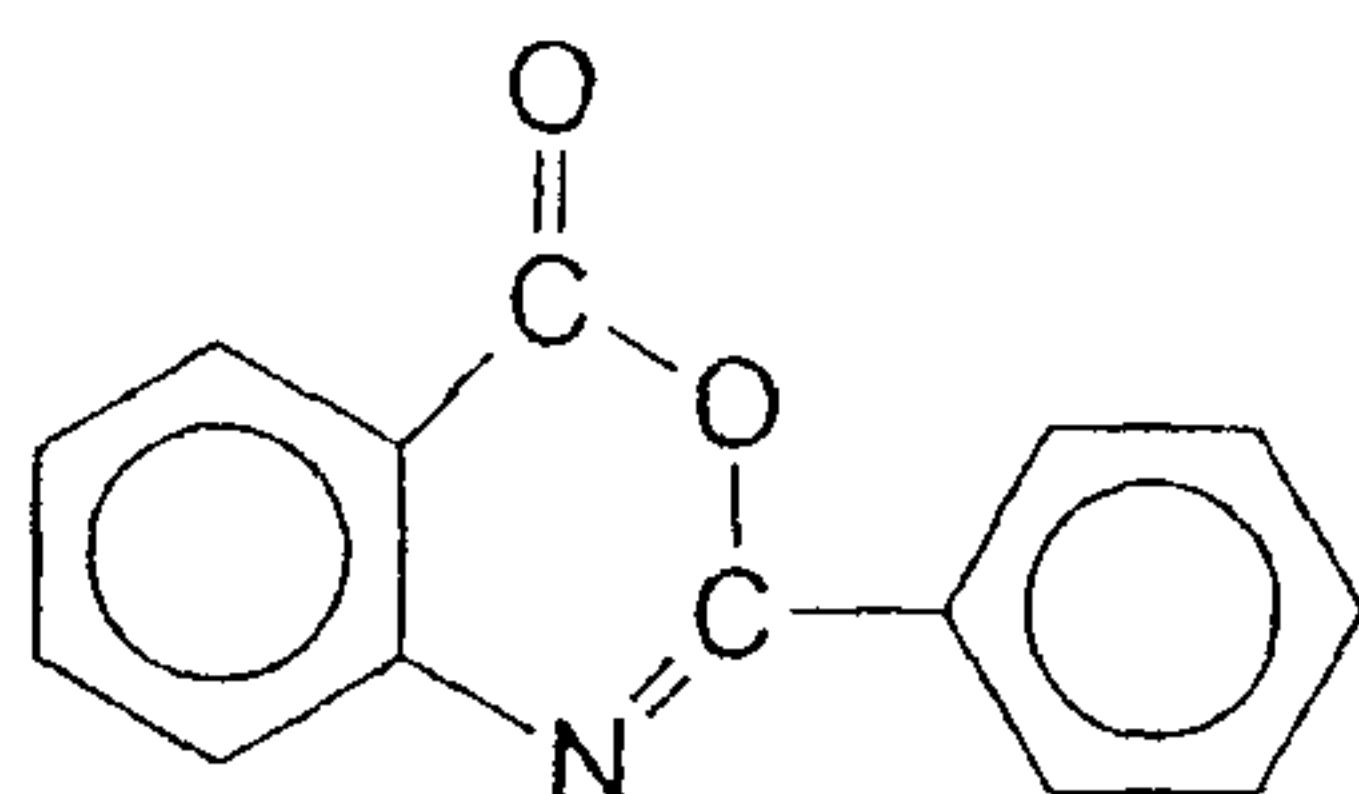


including the substituted benzoxazins of the type



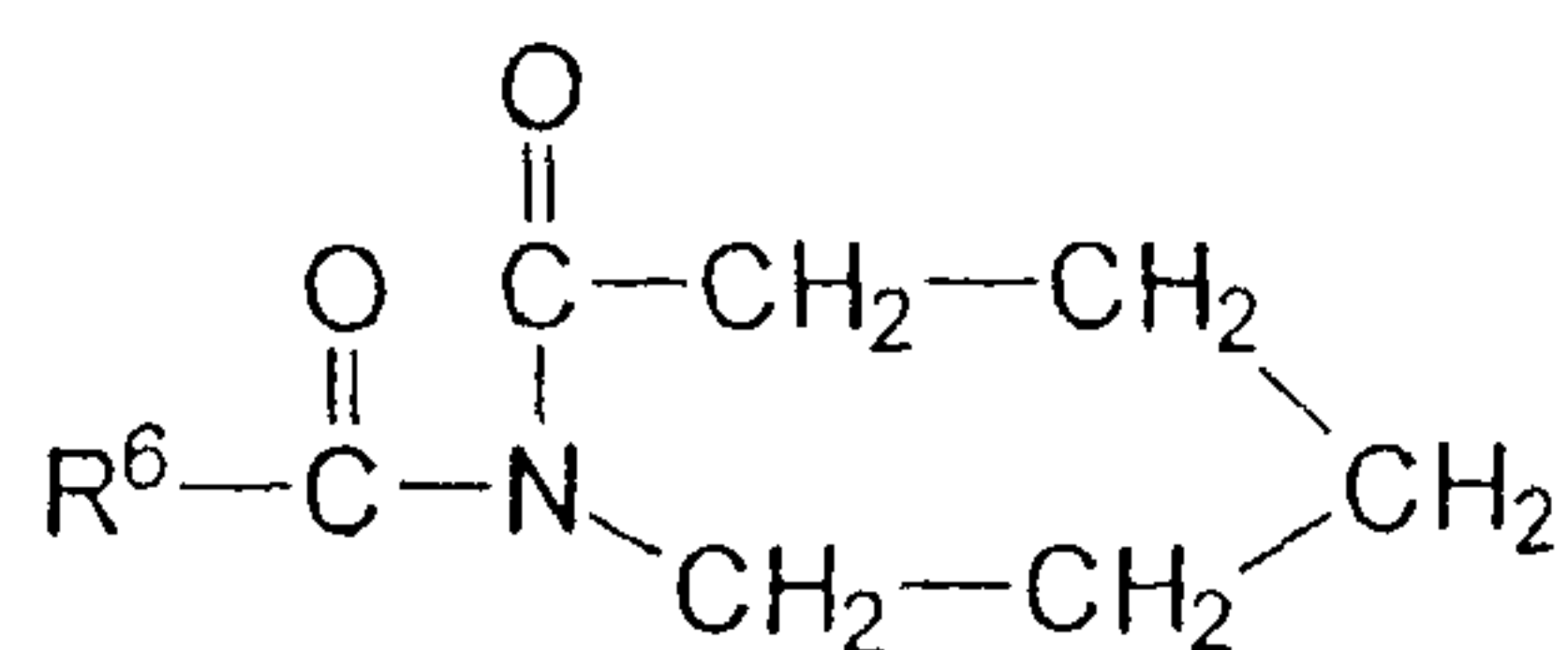
wherein R_1 is H, alkyl, alkaryl, aryl, arylalkyl, and wherein R_2 , R_3 , R_4 , and R_5 may be the same or different substituents selected from H, halogen, alkyl, alkenyl, aryl, hydroxyl, alkoxyl, amino, alkylamino, and $-\text{COOR}_6$, wherein R_6 is H or an alkyl group and carbonyl functions.

A preferred activator of the benzoxazin-type is:



When the activators are used, optimum surface bleaching performance is obtained with washing solutions wherein the pH of such solution is between about 8.5 and 10.5 and preferably between 9.5 and 10.5 in order to facilitate the perhydrolysis reaction. Such pH can be obtained with substances commonly known as buffering agents, which are optional components of the bleaching systems herein.

- N-Acyl Caprolactam Bleach Activators - The N-acyl caprolactam bleach activators of type c) employed in the present invention have the formula:



wherein R^6 is H or an alkyl, aryl, alkoxyaryl, or alkaryl group containing from 1 to 12 carbons. Caprolactam activators wherein the R^6 moiety contains at least about 6, preferably from 6 to about 12, carbon atoms provide hydrophobic bleaching which affords nucleophilic and body soil clean-up, as noted above. Caprolactam activators wherein R^6 comprises from 1 to about 6 carbon atoms provide hydrophilic bleaching species which are particularly efficient for bleaching beverage stains. Mixtures of hydrophobic and hydrophilic caprolactams, typically at weight ratios of 1:5 to 5:1, preferably 1:1, can be used herein for mixed stain removal benefits.

Highly preferred N-acyl caprolactams are selected from the group consisting of benzoyl caprolactam, octanoyl caprolactam, nonanoyl caprolactam, 3,5,5-

trimethylhexanoyl caprolactam, decanoyl caprolactam, undecenoyl caprolactam, and mixtures thereof. Methods for making N-acyl caprolactams are well known in the art.

Contrary to the teachings of U.S. Pat. 4,545,784, the bleach activator is preferably not absorbed onto the peroxygen bleaching compound. To do so in the presence of other organic detergent ingredients could cause safety problems.

The bleach activators of type a), b) or c) will comprise at least about 0.01%, preferably from about 0.1%, more preferably from about 1%, most preferably from about 3% to about 50%, preferably to about 30%, more preferably to about 15%, still more preferably to about 10%, most preferably to about 8% by weight of bleaching system or bleaching composition.

The preferred amido-derived and caprolactam bleach activators herein can also be used in combination with rubber-safe, enzyme-safe, hydrophilic activators such as TAED, typically at weight ratios of amido-derived or caprolactam activators:TAED in the range of 1:5 to 5:1, preferably about 1:1.

Highly preferred bleach activators are selected from the group consisting of tetraacetyl ethylene diamine (TAED), benzoylcaprolactam (BzCL), 4-nitrobenzoylcaprolactam, 3-chlorobenzoylcaprolactam, benzoyloxybenzenesulphonate (BOBS), nonanoyloxybenzenesulphonate (NOBS), phenyl benzoate (PhBz), decanoyloxybenzenesulphonate (C₁₀-OBS), benzoylvalerolactam (BZVL), octanoyloxybenzenesulphonate (C₈-OBS), perhydrolyzable esters and mixtures thereof, most preferably benzoylcaprolactam and benzoylvalerolactam. Particularly preferred bleach activators in the pH range from about 8 to about 9.5 are those selected having an OBS or VL leaving group.

Additional preferred bleach activators are those described in U.S. 5,698,504 Christie et al., issued December 16, 1997; U.S. 5,695,679 Christie et al. issued December 9, 1997; U.S. 5,686,401 Willey et al., issued November 11, 1997; U.S. 5,686,014 Hartshorn et al., issued November 11, 1997; U.S. 5,405,412 Willey et al., issued April 11, 1995; U.S. 5,405,413 Willey et al., issued April 11, 1995; U.S. 5,130,045 Mitchel et al., issued July 14, 1992; and U.S. 4,412,934 Chung et al., issued November 1, 1983, and U.S. Patent No. 5,998,350, issued December 7, 1999.

Preferred hydrophobic bleach activators include, but are not limited to, nonanoyloxybenzenesulphonate (NOBS), 4-[N-(nonaoyl) amino hexanoyloxy]-benzene sulfonate sodium salt (NACA-OBS) an example of which is described in U.S. Patent No. 5,523,434, dodecanoyloxybenzenesulphonate (LOBS or C₁₂-OBS), 10-undecenoyloxybenzenesulfonate (UDOBS or C₁₁-OBS with unsaturation in the 10 position), and decanoyloxybenzoic acid (DOBA).

Quaternary substituted bleach activators may also be included. The present cleaning compositions preferably comprise a quaternary substituted bleach activator (QSBA) or a quaternary substituted peracid (QSP); more preferably, the former. Preferred QSBA structures are further described in U.S. 5,686,015 Willey et al., issued November 11, 1997; U.S. 5,654,421 Taylor et al., issued August 5, 1997; U.S. 5,460,747 Gosselink et al., issued October 24, 1995; U.S. 5,584,888 Miracle et al., issued December 17, 1996; and U.S. 5,578,136 Taylor et al., issued November 26, 1996.

Highly preferred bleach activators useful herein are amide-substituted as described in U.S. 5,698,504, U.S. 5,695,679, and U.S. 5,686,014 each of which are cited herein above. Preferred examples of such bleach activators include: (6-octanamidocaproyl)oxybenzenesulfonate, (6-nonanamidocaproyl)oxybenzenesulfonate, (6-decanamidocaproyl)oxybenzenesulfonate and mixtures thereof.

Other useful activators, disclosed in U.S. 5,698,504, U.S. 5,695,679, U.S. 5,686,014 each of which is cited herein above and U.S. 4,966,723 Hodge et al., issued October 30, 1990, include benzoxazin-type activators, such as a C_6H_4 ring to which is fused in the 1,2-positions a moiety $--C(O)OC(R^1)=N-$.

Depending on the activator and precise application, good bleaching results can be obtained from bleaching systems having with in-use pH of from about 6 to about 13, preferably from about 9.0 to about 10.5. Typically, for example, activators with electron-withdrawing moieties are used for near-neutral or sub-neutral pH ranges. Alkalis and buffering agents can be used to secure such pH.

Acyl lactam activators, as described in U.S. 5,698,504, U.S. 5,695,679 and U.S. 5,686,014, each of which is cited herein above, are very useful herein, especially the acyl caprolactams (see for example WO 94-28102 A) and acyl valerolactams (see U.S. 5,503,639 Willey et al., issued April 2, 1996).

The bleaching mechanism generally, and the surface bleaching mechanism in particular, are not completely understood. However, it is generally believed that the bleach activator undergoes nucleophilic attack by a perhydroxide anion, which is generated from the hydrogen peroxide evolved by the peroxygen bleach, to form a peroxycarboxylic acid. This reaction is commonly referred to as perhydrolysis.

When the activators are used, optimum surface bleaching performance is obtained with washing solutions wherein the pH of such solution is between about 8.5 and 10.5 and preferably between 9.5 and 10.5 in order to facilitate the perhydrolysis reaction. Such pH can be obtained with substances commonly known as buffering agents, which are optional components of the bleaching systems herein.

(ii) The Peroxygen Bleaching Compound

The peroxygen bleaching systems useful herein are those capable of yielding hydrogen peroxide in an aqueous liquor. These compounds are well known in the art and include hydrogen peroxide and the alkali metal peroxides, organic peroxide bleaching compounds such as urea peroxide, and inorganic persalt bleaching compounds, such as the alkali metal perborates, percarbonates, perphosphates, and the like. Mixtures of two or more such bleaching compounds can also be used, if desired.

Hydrogen peroxide sources are described in detail in Kirk Othmer's Encyclopedia of Chemical Technology, 4th Ed (1992, John Wiley & Sons), Vol. 4, pp. 271-300 "Bleaching Agents (Survey)", and include the various forms of sodium perborate and sodium percarbonate, including various coated and modified forms.

Preferred peroxygen bleaching compounds include sodium perborate, commercially available in the form of mono-, tri-, and tetra-hydrate, sodium pyrophosphate peroxyhydrate, urea peroxyhydrate, sodium percarbonate, and sodium peroxide. Particularly preferred are sodium perborate tetrahydrate, sodium perborate monohydrate and sodium percarbonate. Percarbonate is especially preferred because it is very stable during storage and yet still dissolves very quickly in the bleaching liquor. It is believed that such rapid dissolution results in the formation of higher levels of percarboxylic acid and, thus, enhanced surface bleaching performance.

Highly preferred percarbonate can be in uncoated or coated form. The average particle size of uncoated percarbonate ranges from about 400 to about 1200 microns, most preferably from about 400 to about 600 microns. If coated percarbonate is used, the preferred coating materials include mixtures of carbonate and sulphate, silicate, borosilicate, or fatty carboxylic acids.

The peroxygen bleaching compound will comprise at least about 0.1%, preferably from about 1% to about 75%, more preferably from about 3% to about 40%, most preferably from about 3% to about 25%, by weight of bleaching system or bleaching composition.

The weight ratio of bleach activator to peroxygen bleaching compound in the bleaching system typically ranges from about 2:1 to 1:5. Preferred ratios range from about 1:1 to about 1:3.

The mole ratio of peroxygen bleaching compound (as AvO) to bleach activator in the present invention generally ranges from at least 1:1, preferably from at least 1.5:1, most preferably from at least 2:1, to about 20:1, preferably to about 10:1, more preferably to about 3:1. Preferably, the bleaching compositions herein comprise from about 0.5 to about 20, most preferably from about 1 to about 10, wt.% of the peroxygen bleaching compound.

The bleach activator/bleaching compound systems herein are useful per se as bleaches. However, such bleaching systems are especially useful in compositions which can comprise various deterative adjuncts such as surfactants, builders and the like.

Bleach Catalysts - The compositions herein may further comprise one or more bleach catalysts. Preferred bleach catalysts are zwitterionic bleach catalysts, which are described in U.S. Patent Nos. 5,576,282 and 5,817,614 (especially 3-(3,4-dihydroisoquinolinium) propane sulfonate. Other bleach catalysts include cationic bleach catalysts are described in U.S. Patent Nos. 5,360,569, 5,442,066, 5,478,357, 5,370,826, 5,482,515, 5,550,256, and WO 95/13351, WO 95/13352, and WO 95/13353.

BLEACHING COMPOSITIONS

The bleaching compositions of the present invention also comprise, in addition to one or more protease variants and one or more bleaching agents described hereinbefore, one or more cleaning adjunct materials, preferably compatible with the protease variant(s) and bleaching agent(s). The term "compatible", as used herein, means the bleaching composition materials do not reduce the proteolytic activity of the protease enzyme to such an extent that the protease is not effective as desired during normal use situations. The term "cleaning adjunct materials", as used herein, means any liquid, solid or gaseous material selected for the particular type of bleaching composition desired and the form of the product (e.g., liquid; granule; powder; bar; paste; spray; tablet; gel; foam composition), which materials are also preferably compatible with the protease enzyme(s) and bleaching agent(s) used in the composition. Granular compositions can also be in "compact" form and the liquid compositions can also be in a "concentrated" form.

The specific selection of cleaning adjunct materials are readily made by considering the surface, item or fabric to be cleaned, and the desired form of the composition for the cleaning conditions during use (e.g., through the wash detergent use). Examples of suitable cleaning adjunct materials include, but are not limited to, surfactants, builders, bleaches, bleach activators, bleach catalysts, other enzymes, enzyme stabilizing systems, chelants, optical brighteners, soil release polymers, dye transfer agents, dispersants, suds suppressors, dyes, perfumes, colorants, filler salts, hydrotropes, photoactivators, fluorescers, fabric conditioners, hydrolyzable surfactants, preservatives, anti-oxidants, anti-shrinkage agents, anti-wrinkle agents, germicides, fungicides, color speckles, silvercare, anti-tarnish and/or anti-corrosion agents, alkalinity sources, solubilizing agents, carriers, processing aids, pigments and pH control agents as described in U.S. Patent Nos. 5,705,464, 5,710,115, 5,698,504, 5,695,679, 5,686,014 and 5,646,101. Specific bleaching composition materials are exemplified in detail hereinafter.

If the cleaning adjunct materials are not compatible with the protease variant(s) in the bleaching compositions, then suitable methods of keeping the cleaning adjunct

materials and the protease variant(s) separate (not in contact with each other) until combination of the two components is appropriate can be used. Suitable methods can be any method known in the art, such as gelcaps, encapsulation, tablets, physical separation, etc.

Preferably, an effective amount of one or more protease variants described above are included in compositions useful for cleaning a variety of surfaces in need of proteinaceous stain removal. Such bleaching compositions include detergent compositions for cleaning hard surfaces, unlimited in form (e.g., liquid, granular, paste, foam, spray, etc.); detergent compositions for cleaning fabrics, unlimited in form (e.g., granular, liquid, bar formulations, etc.); dishwashing compositions (unlimited in form and including both granular and liquid automatic dishwashing); oral bleaching compositions, unlimited in form (e.g., dentifrice, toothpaste and mouthwash formulations); and denture bleaching compositions, unlimited in form (e.g., liquid, tablet).

The fabric bleaching compositions of the present invention are mainly intended to be used in the wash cycle of a washing machine; however, other uses can be contemplated, such as pretreatment product for heavily-soiled fabrics, or soaking product; the use is not necessarily limited to the washing-machine context, and the compositions of the present invention can be used alone or in combination with compatible handwash compositions.

As used herein, "effective amount of protease variant" refers to the quantity of protease variant described hereinbefore necessary to achieve the enzymatic activity necessary in the specific bleaching composition. Such effective amounts are readily ascertained by one of ordinary skill in the art and is based on many factors, such as the particular variant used, the cleaning application, the specific composition of the bleaching composition, and whether a liquid or dry (e.g., granular, bar) composition is required, and the like.

When the bleaching composition is a personal cleansing composition the ratio of soap to protease variant is from 2,000:1 to 8:1, preferably from 400:1 to 40:1.

Preferably the bleaching compositions comprise from about 0.0001% to about 10% of one or more protease variants of the present invention, more preferably from about 0.001% to about 1%, more preferably still from about 0.001% to about 0.1%. Also preferably the protease variant of the present invention is present in the compositions in an amount sufficient to provide a ratio of mg of active protease per 100 grams of composition to ppm theoretical Available O₂ ("AvO₂") from any peroxyacid in the wash liquor, referred to herein as the Enzyme to Bleach ratio (E/B ratio), ranging from about 1:1 to about 20:1. Several examples of various bleaching compositions wherein the protease variants of the present invention may be employed are discussed in further detail below. Also, the bleaching compositions may include from about 1% to about 99.9% by weight of the composition of the cleaning adjunct materials.

As used herein, "non-fabric bleaching compositions" include hard surface bleaching compositions, dishwashing compositions, oral bleaching compositions, denture bleaching compositions and personal cleansing compositions.

When the bleaching compositions of the present invention are formulated as compositions suitable for use in a laundry machine washing method, the compositions of the present invention preferably contain both a surfactant and a builder compound and additionally one or more cleaning adjunct materials preferably selected from organic polymeric compounds, bleaching agents, additional enzymes, suds suppressors, dispersants, lime-soap dispersants, soil suspension and anti-redeposition agents and corrosion inhibitors. Laundry compositions can also contain softening agents, as additional cleaning adjunct materials.

The compositions of the present invention can also be used as detergent additive products in solid or liquid form. Such additive products are intended to supplement or boost the performance of conventional detergent compositions and can be added at any stage of the cleaning process.

When formulated as compositions for use in manual dishwashing methods the compositions of the invention preferably contain a surfactant and preferably other cleaning adjunct materials selected from organic polymeric compounds, suds enhancing agents, group II metal ions, solvents, hydrotropes and additional enzymes.

If needed the density of the laundry detergent compositions herein ranges from 400 to 1200 g/litre, preferably 500 to 950 g/litre of composition measured at 20°C.

The "compact" form of the bleaching compositions herein is best reflected by density and, in terms of composition, by the amount of inorganic filler salt; inorganic filler salts are conventional ingredients of detergent compositions in powder form; in conventional detergent compositions, the filler salts are present in substantial amounts, typically 17-35% by weight of the total composition. In the compact compositions, the filler salt is present in amounts not exceeding 15% of the total composition, preferably not exceeding 10%, most preferably not exceeding 5% by weight of the composition. The inorganic filler salts, such as meant in the present compositions are selected from the alkali and alkaline-earth-metal salts of sulfates and chlorides. A preferred filler salt is sodium sulfate.

Liquid bleaching compositions according to the present invention can also be in a "concentrated form", in such case, the liquid bleaching compositions according the present invention will contain a lower amount of water, compared to conventional liquid detergents. Typically the water content of the concentrated liquid bleaching composition is preferably less than 40%, more preferably less than 30%, most preferably less than 20% by weight of the bleaching composition.

Cleaning Adjunct Materials

Surfactant System - Deterative surfactants included in the fully-formulated bleaching compositions afforded by the present invention comprises at least 0.01%, preferably at least about 0.1%, more preferably at least about 0.5%, most preferably at least about 1% to about 60%, more preferably to about 35%, most preferably to about 30% by weight of bleaching composition depending upon the particular surfactants used and the desired effects.

The deterative surfactant can be nonionic, anionic, ampholytic, zwitterionic, cationic, semi-polar nonionic, and mixtures thereof, nonlimiting examples of which are disclosed in U.S. Patent Nos. 5,707,950 and 5,576,282. Preferred detergent and bleaching compositions comprise anionic deterative surfactants or mixtures of anionic surfactants with other surfactants, especially nonionic surfactants.

Nonlimiting examples of surfactants useful herein include the conventional C₁₁-C₁₈ alkyl benzene sulfonates and primary, secondary and random alkyl sulfates, the C₁₀-C₁₈ alkyl alkoxy sulfates, the C₁₀-C₁₈ alkyl polyglycosides and their corresponding sulfated polyglycosides, C₁₂-C₁₈ alpha-sulfonated fatty acid esters, C₁₂-C₁₈ alkyl and alkyl phenol alkoxylates (especially ethoxylates and mixed ethoxy/propoxy), C₁₂-C₁₈ betaines and sulfobetaines ("sultaines"), C₁₀-C₁₈ amine oxides, and the like. Other conventional useful surfactants are listed in standard texts.

The surfactant is preferably formulated to be compatible with enzyme components present in the composition. In liquid or gel compositions the surfactant is most preferably formulated such that it promotes, or at least does not degrade, the stability of any enzyme in these compositions.

Nonionic Surfactants - Polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols are suitable for use as the nonionic surfactant of the surfactant systems of the present invention, with the polyethylene oxide condensates being preferred. Commercially available nonionic surfactants of this type include IgepalTM CO-630, marketed by the GAF Corporation; and TritonTM X-45, X-114, X-100 and X-102, all marketed by the Rohm & Haas Company. These surfactants are commonly referred to as alkylphenol alkoxylates (e.g., alkyl phenol ethoxylates).

The condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide are suitable for use as the nonionic surfactant of the nonionic surfactant systems of the present invention. Examples of commercially available nonionic surfactants of this type include TergitolTM 15-S-9 (the condensation product of C₁₁-C₁₅ linear alcohol with 9 moles ethylene oxide), TergitolTM 24-L-6 NMW (the condensation product of C₁₂-C₁₄ primary alcohol with 6 moles ethylene oxide with a narrow molecular weight distribution), both marketed by Union Carbide Corporation; NeodolTM 45-9 (the condensation product of C₁₄-C₁₅ linear alcohol with 9 moles of

ethylene oxide), NeodolTM 23-3 (the condensation product of C₁₂-C₁₃ linear alcohol with 3.0 moles of ethylene oxide), NeodolTM 45-7 (the condensation product of C₁₄-C₁₅ linear alcohol with 7 moles of ethylene oxide), NeodolTM 45-5 (the condensation product of C₁₄-C₁₅ linear alcohol with 5 moles of ethylene oxide) marketed by Shell Chemical Company, KyroTM EOB (the condensation product of C₁₃-C₁₅ alcohol with 9 moles ethylene oxide), marketed by The Procter & Gamble Company, and Genapol LA O3O or O5O (the condensation product of C₁₂-C₁₄ alcohol with 3 or 5 moles of ethylene oxide) marketed by Hoechst. Preferred range of HLB in these products is from 8-11 and most preferred from 8-10.

Also useful as the nonionic surfactant of the surfactant systems of the present invention are the alkylpolysaccharides disclosed in U.S. Patent No. 4,565,647.

Preferred alkylpolyglycosides have the formula: $R^2O(C_nH_{2n}O)_t(\text{glycosyl})_x$ wherein R² is selected from the group consisting of alkyl, alkylphenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from about 1.3 to about 10, preferably from about 1.3 to about 3, most preferably from about 1.3 to about 2.7.

The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are also suitable for use as the additional nonionic surfactant systems of the present invention. Examples of compounds of this type include certain of the commercially-available PlurafacTM LF404 and PluronicTM surfactants, marketed by BASF.

Also suitable for use as the nonionic surfactant of the nonionic surfactant system of the present invention, are the condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. Examples of this type of nonionic surfactant include certain of the commercially available TetronicTM compounds, marketed by BASF.

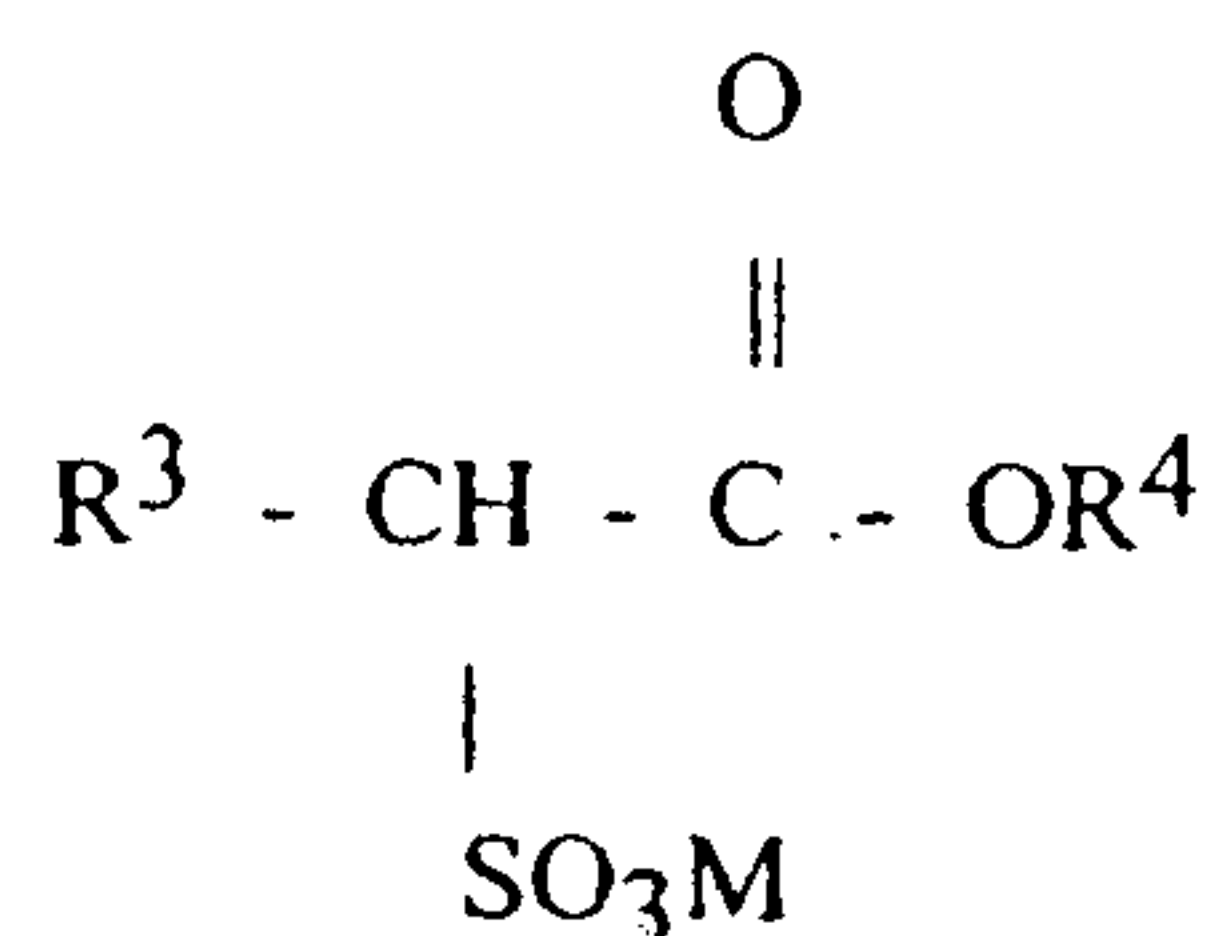
Preferred for use as the nonionic surfactant of the surfactant systems of the present invention are polyethylene oxide condensates of alkyl phenols, condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide, alkylpolysaccharides, and mixtures thereof. Most preferred are C₈-C₁₄ alkyl phenol ethoxylates having from 3 to 15 ethoxy groups and C₈-C₁₈ alcohol ethoxylates (preferably C₁₀ avg.) having from 2 to 10 ethoxy groups, and mixtures thereof.

Highly preferred nonionic surfactants are polyhydroxy fatty acid amide surfactants of the formula: $R^2 - C(O) - N(R^1) - Z$ wherein R¹ is H, or R¹ is C₁₋₄ hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl or a mixture thereof, R² is C₅₋₃₁ hydrocarbyl, and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls

directly connected to the chain, or an alkoxyated derivative thereof. Preferably, R^1 is methyl, R^2 is a straight C_{11-15} alkyl or C_{16-18} alkyl or alkenyl chain such as coconut alkyl or mixtures thereof, and Z is derived from a reducing sugar such as glucose, fructose, maltose, lactose, in a reductive amination reaction.

Anionic Surfactants - Suitable anionic surfactants to be used are linear alkyl benzene sulfonate, alkyl ester sulfonate surfactants including linear esters of C_8 - C_{20} carboxylic acids (i.e., fatty acids) which are sulfonated with gaseous SO_3 according to "The Journal of the American Oil Chemists Society", 52 (1975), pp. 323-329. Suitable starting materials would include natural fatty substances as derived from tallow, palm oil, etc.

The preferred alkyl ester sulfonate surfactant, especially for laundry applications, comprise alkyl ester sulfonate surfactants of the structural formula :



wherein R^3 is a C_8 - C_{20} hydrocarbyl, preferably an alkyl, or combination thereof, R^4 is a C_1 - C_6 hydrocarbyl, preferably an alkyl, or combination thereof, and M is a cation which forms a water soluble salt with the alkyl ester sulfonate. Suitable salt-forming cations include metals such as sodium, potassium, and lithium, and substituted or unsubstituted ammonium cations, such as monoethanolamine, diethanolamine, and triethanolamine. Preferably, R^3 is C_{10} - C_{16} alkyl, and R^4 is methyl, ethyl or isopropyl. Especially preferred are the methyl ester sulfonates wherein R^3 is C_{10} - C_{16} alkyl.

Other suitable anionic surfactants include the alkyl sulfate surfactants which are water soluble salts or acids of the formula ROSO_3M wherein R preferably is a C_{10} - C_{24} hydrocarbyl, preferably an alkyl or hydroxyalkyl having a C_{10} - C_{20} alkyl component, more preferably a C_{12} - C_{18} alkyl or hydroxyalkyl, and M is H or a cation. Typically, alkyl chains of C_{12} - C_{16} are preferred for lower wash temperatures (e.g. below about 50°C) and C_{16-18} alkyl chains are preferred for higher wash temperatures (e.g. above about 50°C).

Other anionic surfactants useful for deterative purposes include salts of soap, C_8 - C_{22} primary or secondary alkanesulfonates, C_8 - C_{24} olefinsulfonates, sulfonated polycarboxylic acids prepared by sulfonation of the pyrolyzed product of alkaline earth metal citrates, e.g., as described in British patent specification No. 1,082,179, C_8 - C_{24} alkylpolyglycol ethersulfates (containing up to 10 moles of ethylene oxide); alkyl glycerol sulfonates, fatty acyl glycerol sulfonates, fatty oleyl glycerol sulfates, alkyl phenol ethylene oxide ether sulfates, paraffin sulfonates, alkyl phosphates, isethionates such as the acyl isethionates, N-acyl taurates, alkyl succinamates and sulfosuccinates, monoesters of

sulfosuccinates (especially saturated and unsaturated C₁₂-C₁₈ monoesters) and diesters of sulfosuccinates (especially saturated and unsaturated C₆-C₁₂ diesters), acyl sarcosinates, sulfates of alkylpolysaccharides such as the sulfates of alkylpolyglucoside (the nonionic nonsulfated compounds being described below), branched primary alkyl sulfates, and alkyl polyethoxy carboxylates such as those of the formula RO(CH₂CH₂O)_k-CH₂COO-M⁺ wherein R is a C₈-C₂₂ alkyl, k is an integer from 1 to 10, and M is a soluble salt-forming cation. Resin acids and hydrogenated resin acids are also suitable, such as rosin, hydrogenated rosin, and resin acids and hydrogenated resin acids present in or derived from tall oil.

Further examples are described in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch). A variety of such surfactants are also generally disclosed in U.S. Patent 3,929,678, issued December 30, 1975 to Laughlin, et al. at Column 23, line 58 through Column 29, line 23.

Highly preferred anionic surfactants include alkyl alkoxyated sulfate surfactants hereof are water soluble salts or acids of the formula RO(A)_mSO₃M wherein R is an unsubstituted C₁₀-C₂₄ alkyl or hydroxyalkyl group having a C₁₀-C₂₄ alkyl component, preferably a C₁₂-C₂₀ alkyl or hydroxyalkyl, more preferably C₁₂-C₁₈ alkyl or hydroxyalkyl, A is an ethoxy or propoxy unit, m is greater than zero, typically between about 0.5 and about 6, more preferably between about 0.5 and about 3, and M is H or a cation which can be, for example, a metal cation (e.g., sodium, potassium, lithium, calcium, magnesium, etc.), ammonium or substituted-ammonium cation. Alkyl ethoxylated sulfates as well as alkyl propoxylated sulfates are contemplated herein. Specific examples of substituted ammonium cations include methyl-, dimethyl, trimethyl-ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperdinium cations and those derived from alkylamines such as ethylamine, diethylamine, triethylamine, mixtures thereof, and the like. Exemplary surfactants are C₁₂-C₁₈ alkyl polyethoxylate (1.0) sulfate (C₁₂-C₁₈E(1.0)M), C₁₂-C₁₈ alkyl polyethoxylate (2.25) sulfate (C₁₂-C₁₈E(2.25)M), C₁₂-C₁₈ alkyl polyethoxylate (3.0) sulfate (C₁₂-C₁₈E(3.0)M), and C₁₂-C₁₈ alkyl polyethoxylate (4.0) sulfate (C₁₂-C₁₈E(4.0)M), wherein M is conveniently selected from sodium and potassium.

When included therein, the bleaching compositions of the present invention typically comprise from about 1%, preferably from about 3% to about 40%, preferably about 20% by weight of such anionic surfactants.

Cationic Surfactants - Cationic deterative surfactants suitable for use in the bleaching compositions of the present invention are those having one long-chain hydrocarbyl group. Examples of such cationic surfactants include the ammonium surfactants such as alkyltrimethylammonium halogenides, and those surfactants having the

formula: $[R^2(OR^3)_y][R^4(OR^3)_y]_2R^5N^+X^-$ wherein R^2 is an alkyl or alkyl benzyl group having from about 8 to about 18 carbon atoms in the alkyl chain, each R^3 is selected from the group consisting of $-CH_2CH_2-$, $-CH_2CH(CH_3)-$, $-CH_2CH(CH_2OH)-$, $-CH_2CH_2CH_2-$, and mixtures thereof; each R^4 is selected from the group consisting of C_1 - C_4 alkyl, C_1 - C_4 hydroxyalkyl, benzyl ring structures formed by joining the two R^4 groups, $-CH_2CHOH-CHOHCOR^6CHOHCH_2OH$ wherein R^6 is any hexose or hexose polymer having a molecular weight less than about 1000, and hydrogen when y is not 0; R^5 is the same as R^4 or is an alkyl chain wherein the total number of carbon atoms of R^2 plus R^5 is not more than about 18; each y is from 0 to about 10 and the sum of the y values is from 0 to about 15; and X is any compatible anion.

Highly preferred cationic surfactants are the water-soluble quaternary ammonium compounds useful in the present composition having the formula (i): $R_1R_2R_3R_4N^+X^-$ wherein R_1 is C_8 - C_{16} alkyl, each of R_2 , R_3 and R_4 is independently C_1 - C_4 alkyl, C_1 - C_4 hydroxy alkyl, benzyl, and $-(C_2H_4O)_xH$ where x has a value from 2 to 5, and X is an anion. Not more than one of R_2 , R_3 or R_4 should be benzyl. The preferred alkyl chain length for R_1 is C_{12} - C_{15} particularly where the alkyl group is a mixture of chain lengths derived from coconut or palm kernel fat or is derived synthetically by olefin build up or OXO alcohols synthesis. Preferred groups for R_2R_3 and R_4 are methyl and hydroxyethyl groups and the anion X may be selected from halide, methosulfate, acetate and phosphate ions.

Examples of suitable quaternary ammonium compounds of formulae (i) for use herein are include, but are not limited to: coconut trimethyl ammonium chloride or bromide; coconut methyl dihydroxyethyl ammonium chloride or bromide; decyl triethyl ammonium chloride; decyl dimethyl hydroxyethyl ammonium chloride or bromide; C_{12-15} dimethyl hydroxyethyl ammonium chloride or bromide; coconut dimethyl hydroxyethyl ammonium chloride or bromide; myristyl trimethyl ammonium methyl sulphate; lauryl dimethyl benzyl ammonium chloride or bromide; lauryl dimethyl (ethenoxy) $_4$ ammonium chloride or bromide; choline esters (compounds of formula (i) wherein R_1 is $CH_2-CH_2-O-C-C_{12-14}$ alkyl and $R_2R_3R_4$ are methyl); and di-alkyl imidazolines [(i)].

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Other cationic surfactants useful herein are also described in U.S. Patent 4,228,044, Cambre, issued October 14, 1980 and in European Patent Application EP 000,224.

When included therein, the bleaching compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 25%, preferably to about 8% by weight of such cationic surfactants.

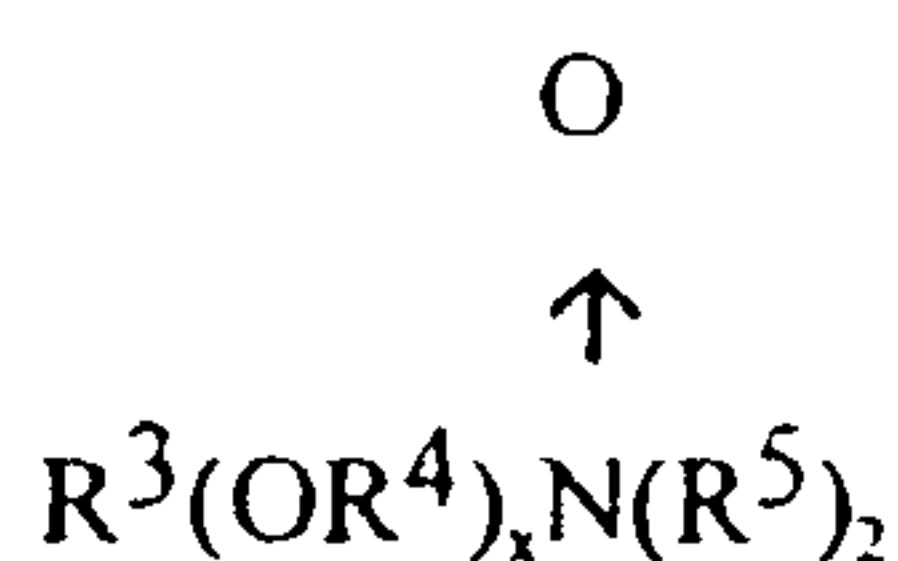
Ampholytic Surfactants - Ampholytic surfactants, examples of which are described in U.S. Patent No. 3,929,678, are also suitable for use in the bleaching compositions of the present invention.

When included therein, the bleaching compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such ampholytic surfactants.

Zwitterionic Surfactants - Zwitterionic surfactants, examples of which are described in U.S. Patent No. 3,929,678, are also suitable for use in bleaching compositions.

When included therein, the bleaching compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such zwitterionic surfactants.

Semi-polar Nonionic Surfactants - Semi-polar nonionic surfactants are a special category of nonionic surfactants which include water-soluble amine oxides having the formula:



wherein R^3 is an alkyl, hydroxyalkyl, or alkyl phenyl group or mixtures thereof containing from about 8 to about 22 carbon atoms; R^4 is an alkylene or hydroxyalkylene group containing from about 2 to about 3 carbon atoms or mixtures thereof; x is from 0 to about 3; and each R^5 is an alkyl or hydroxyalkyl group containing from about 1 to about 3 carbon atoms or a polyethylene oxide group containing from about 1 to about 3 ethylene oxide groups (the R^5 groups can be attached to each other, e.g., through an oxygen or nitrogen atom, to form a ring structure); water-soluble phosphine oxides containing one alkyl moiety of from about 10 to about 18 carbon atoms and 2 moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from about 1 to about 3 carbon atoms; and water-soluble sulfoxides containing one alkyl moiety of from about 10 to about 18 carbon atoms and a moiety selected from the group consisting of alkyl and hydroxyalkyl moieties of from about 1 to about 3 carbon atoms.

The amine oxide surfactants in particular include C_{10} - C_{18} alkyl dimethyl amine oxides and C_8 - C_{12} alkoxy ethyl dihydroxy ethyl amine oxides.

When included therein, the cleaning compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such semi-polar nonionic surfactants.

Cosurfactants - The bleaching compositions of the present invention may further comprise a cosurfactant selected from the group of primary or tertiary amines. Suitable primary amines for use herein include amines according to the formula R_1NH_2 wherein R_1

is a C₆-C₁₂, preferably C₆-C₁₀ alkyl chain or R₄X(CH₂)_n, X is -O-, -C(O)NH- or -NH-, R₄ is a C₆-C₁₂ alkyl chain n is between 1 to 5, preferably 3. R₁ alkyl chains may be straight or branched and may be interrupted with up to 12, preferably less than 5 ethylene oxide moieties.

Preferred amines according to the formula herein above are n-alkyl amines. Suitable amines for use herein may be selected from 1-hexylamine, 1-octylamine, 1-decylamine and laurylamine. Other preferred primary amines include C₈-C₁₀ oxypropylamine, octyloxypropylamine, 2-ethylhexyl-oxypropylamine, lauryl amido propylamine and amido propylamine. The most preferred amines for use in the compositions herein are 1-hexylamine, 1-octylamine, 1-decylamine, 1-dodecylamine. Especially desirable are n-dodecyldimethylamine and bishydroxyethylcoconutalkylamine and oleylamine 7 times ethoxylated, lauryl amido propylamine and cocoamido propylamine.

LFNIs - Particularly preferred surfactants in the automatic dishwashing compositions (ADD) of the present invention are low foaming nonionic surfactants (LFNI) which are described in U.S. Patent Nos. 5,705,464 and 5,710,115. LFNI may be present in amounts from 0.01% to about 10% by weight, preferably from about 0.1% to about 10%, and most preferably from about 0.25% to about 4%. LFNIs are most typically used in ADDs on account of the improved water-sheeting action (especially from glass) which they confer to the ADD product. They also encompass non-silicone, nonphosphate polymeric materials further illustrated hereinafter which are known to defoam food soils encountered in automatic dishwashing.

Preferred LFNIs include nonionic alkoxyated surfactants, especially ethoxylates derived from primary alcohols, and blends thereof with more sophisticated surfactants, such as the polyoxypropylene/polyoxyethylene/polyoxypropylene (PO/EO/PO) reverse block polymers as described in U.S. Patent Nos. 5,705,464 and 5,710,115.

LFNIs which may also be used include those POLY-TERGENT® SLF-18 nonionic surfactants from Olin Corp., and any biodegradable LFNI having the melting point properties discussed hereinabove.

These and other nonionic surfactants are well known in the art, being described in more detail in Kirk Othmer's Encyclopedia of Chemical Technology, 3rd Ed., Vol. 22, pp. 360-379, "Surfactants and Detergent Systems".

Bleaching Agents - The compositions of the present invention optionally comprise, in addition to the bleaching system described above, additional bleaching agents, such as chlorine bleaches (although less preferred for compositions which comprise enzymes) examples of which are known in the art, and include sodium dichloroisocyanurate ("NaDCC) and bleach catalysts. When present, these other bleaching agents will typically

be at levels of from about 1%, preferably from about 5% to about 30%, preferably to about 20% by weight of the composition.

(a) Organic Peroxides, especially Diacyl Peroxides - These are extensively illustrated in Kirk Othmer, Encyclopedia of Chemical Technology, Vol. 17, John Wiley and Sons, 1982 at pages 27-90 and especially at pages 63-72. If a diacyl peroxide is used, it will preferably be one which exerts minimal adverse impact on spotting/filming.

(b) Metal-containing Bleach Catalysts - The present invention compositions and methods may utilize metal-containing bleach catalysts that are effective for use in bleaching compositions. Preferred are manganese and cobalt-containing bleach catalysts.

One type of metal-containing bleach catalyst is a catalyst system comprising a transition metal cation of defined bleach catalytic activity, such as copper, iron, titanium, ruthenium tungsten, molybdenum, or manganese cations, an auxiliary metal cation having little or no bleach catalytic activity, such as zinc or aluminum cations, and a sequester having defined stability constants for the catalytic and auxiliary metal cations, particularly ethylenediaminetetraacetic acid, ethylenediaminetetra (methylenephosphonic acid) and water-soluble salts thereof. Such catalysts are disclosed in U.S. 4,430,243 Bragg, issued February 2, 1982.

Manganese Metal Complexes - If desired, the compositions herein can be catalyzed by means of a manganese compound. Such compounds and levels of use are well known in the art and include, for example, the manganese-based catalysts disclosed in U.S. Patent Nos. 5,576,282; 5,246,621; 5,244,594; 5,194,416; and 5,114,606; and European Pat. App. Pub. Nos. 549,271 A1, 549,272 A1, 544,440 A2, and 544,490 A1; Preferred examples of these catalysts include $\text{Mn}^{\text{IV}}_2(\text{u-O})_3(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{PF}_6)_2$, $\text{Mn}^{\text{III}}_2(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_2$, $\text{Mn}^{\text{IV}}_4(\text{u-O})_6(1,4,7\text{-triazacyclononane})_4(\text{ClO}_4)_4$, $\text{Mn}^{\text{III}}\text{Mn}^{\text{IV}}_4(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_3$, $\text{Mn}^{\text{IV}}(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})\text{-(OCH}_3)_3(\text{PF}_6)$, and mixtures thereof. Other metal-based bleach catalysts include those disclosed in U.S. Patent Nos. 4,430,243 and U.S. 5,114,611. The use of manganese with various complex ligands to enhance bleaching is also reported in the following: U.S. Patent Nos. 4,728,455; 5,284,944; 5,246,612; 5,256,779; 5,280,117; 5,274,147; 5,153,161; and 5,227,084.

Cobalt Metal Complexes - Cobalt bleach catalysts useful herein are known, and are described, for example, in U.S. Patent Nos. 5,597,936; 5,595,967; and 5,703,030; and M. L. Tobe, "Base Hydrolysis of Transition-Metal Complexes", Adv. Inorg. Bioinorg. Mech., (1983), 2, pages 1-94. The most preferred cobalt catalyst useful herein are cobalt pentaamine acetate salts having the formula $[\text{Co}(\text{NH}_3)_5\text{OAc}] \text{ T}_y$, wherein "OAc"

represents an acetate moiety and "T_y" is an anion, and especially cobalt pentaamine acetate chloride, [Co(NH₃)₅OAc]Cl₂; as well as [Co(NH₃)₅OAc](OAc)₂; [Co(NH₃)₅OAc](PF₆)₂; [Co(NH₃)₅OAc](SO₄); [Co(NH₃)₅OAc](BF₄)₂; and [Co(NH₃)₅OAc](NO₃)₂ (herein "PAC").

These cobalt catalysts are readily prepared by known procedures, such as taught for example in U.S. Patent Nos. 5,597,936; 5,595,967; and 5,703,030; in the Tobe article and the references cited therein; and in U.S. Patent 4,810,410; J. Chem. Ed. (1989), 66 (12), 1043-45; The Synthesis and Characterization of Inorganic Compounds, W.L. Jolly (Prentice-Hall; 1970), pp. 461-3; Inorg. Chem., 18, 1497-1502 (1979); Inorg. Chem., 21, 2881-2885 (1982); Inorg. Chem., 18, 2023-2025 (1979); Inorg. Synthesis, 173-176 (1960); and Journal of Physical Chemistry, 56, 22-25 (1952).

Transition Metal Complexes of Macropolycyclic Rigid Ligands - Compositions herein may also suitably include as bleach catalyst a transition metal complex of a macropolycyclic rigid ligand. The phrase "macropolycyclic rigid ligand" is sometimes abbreviated as "MRL" in discussion below. The amount used is a catalytically effective amount, suitably about 1 ppb or more, for example up to about 99.9%, more typically about 0.001 ppm or more, preferably from about 0.05 ppm to about 500 ppm (wherein "ppb" denotes parts per billion by weight and "ppm" denotes parts per million by weight).

Suitable transition metals e.g., Mn are illustrated hereinafter. "Macropolycyclic" means a MRL is both a macrocycle and is polycyclic. "Polycyclic" means at least bicyclic. The term "rigid" as used herein herein includes "having a superstructure" and "cross-bridged". "Rigid" has been defined as the constrained converse of flexibility: see D.H. Busch., Chemical Reviews, (1993), 93, 847-860 . More particularly, "rigid" as used herein means that the MRL must be determinably more rigid than a macrocycle ("parent macrocycle") which is otherwise identical (having the same ring size and type and number of atoms in the main ring) but lacking a superstructure (especially linking moieties or, preferably cross-bridging moieties) found in the MRL's. In determining the comparative rigidity of macrocycles with and without superstructures, the practitioner will use the free form (not the metal-bound form) of the macrocycles. Rigidity is well-known to be useful in comparing macrocycles; suitable tools for determining, measuring or comparing rigidity include computational methods (see, for example, Zimmer, Chemical Reviews, (1995), 95(38), 2629-2648 or Hancock et al., Inorganica Chimica Acta, (1989), 164, 73-84.

Preferred MRL's herein are a special type of ultra-rigid ligand which is cross-bridged. A "cross-bridge" is nonlimitingly illustrated in 1.11 hereinbelow. In 1.11, the cross-bridge is a -CH₂CH₂- moiety. It bridges N¹ and N⁸ in the illustrative structure. By comparison, a "same-side" bridge, for example if one were to be introduced across N¹ and

N¹² in 1.11, would not be sufficient to constitute a “cross-bridge” and accordingly would not be preferred.

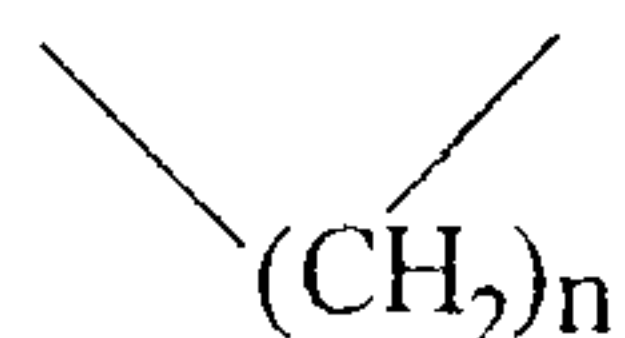
Suitable metals in the rigid ligand complexes include Mn(II), Mn(III), Mn(IV), Mn(V), Fe(II), Fe(III), Fe(IV), Co(I), Co(II), Co(III), Ni(I), Ni(II), Ni(III), Cu(I), Cu(II), Cu(III), Cr(II), Cr(III), Cr(IV), Cr(V), Cr(VI), V(III), V(IV), V(V), Mo(IV), Mo(V), Mo(VI), W(IV), W(V), W(VI), Pd(II), Ru(II), Ru(III), and Ru(IV). Preferred transition-metals in the instant transition-metal bleach catalyst include manganese, iron and chromium.

More generally, the MRL's (and the corresponding transition-metal catalysts) herein suitably comprise:

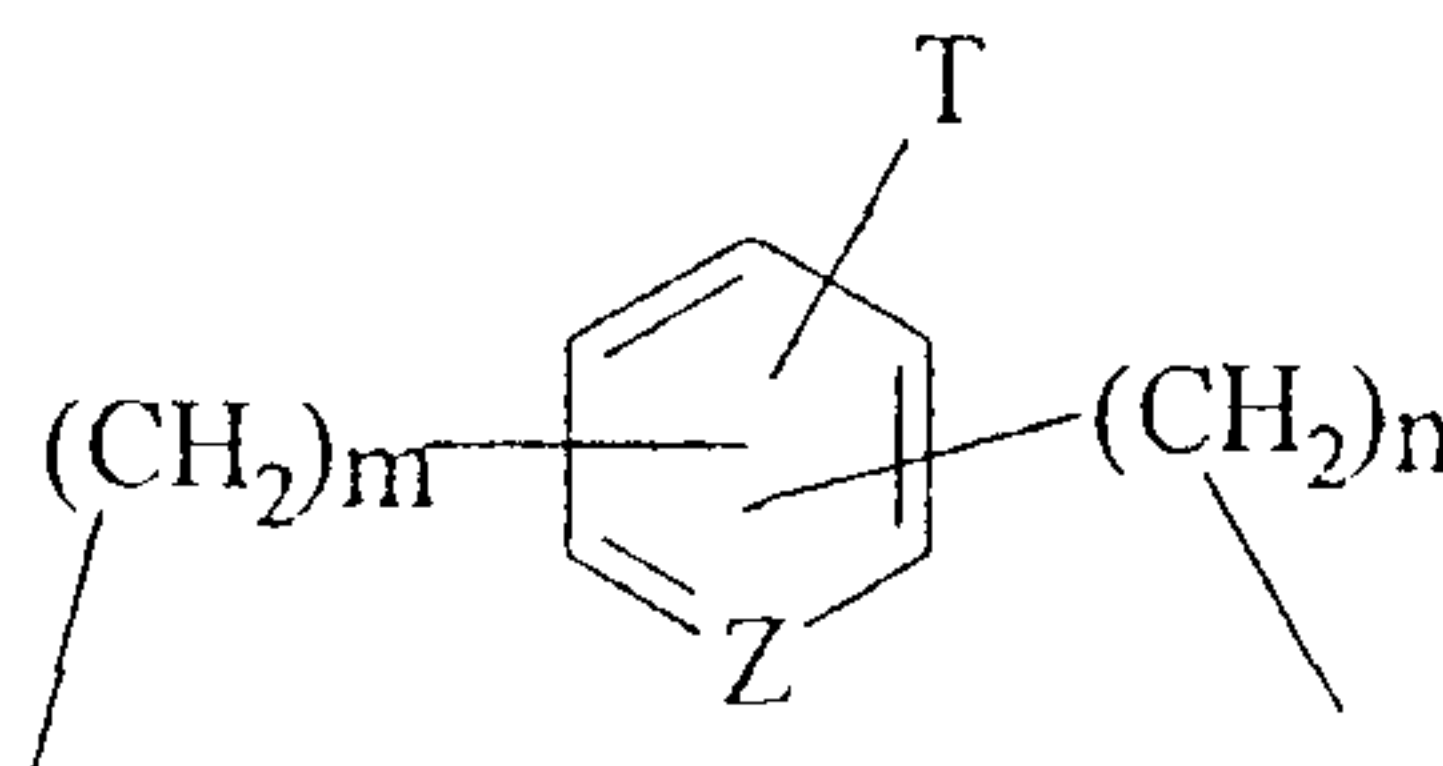
- (a) at least one macrocycle main ring comprising four or more heteroatoms; and
- (b) a covalently connected non-metal superstructure capable of increasing the rigidity of the macrocycle, preferably selected from
 - (i) a bridging superstructure, such as a linking moiety;
 - (ii) a cross-bridging superstructure, such as a cross-bridging linking moiety; and
 - (iii) combinations thereof.

The term “superstructure” is used herein as defined in the literature by Busch et al., see, for example, articles by Busch in “Chemical Reviews”.

Preferred superstructures herein not only enhance the rigidity of the parent macrocycle, but also favor folding of the macrocycle so that it co-ordinates to a metal in a cleft. Suitable superstructures can be remarkably simple, for example a linking moiety such as any of those illustrated below, can be used.



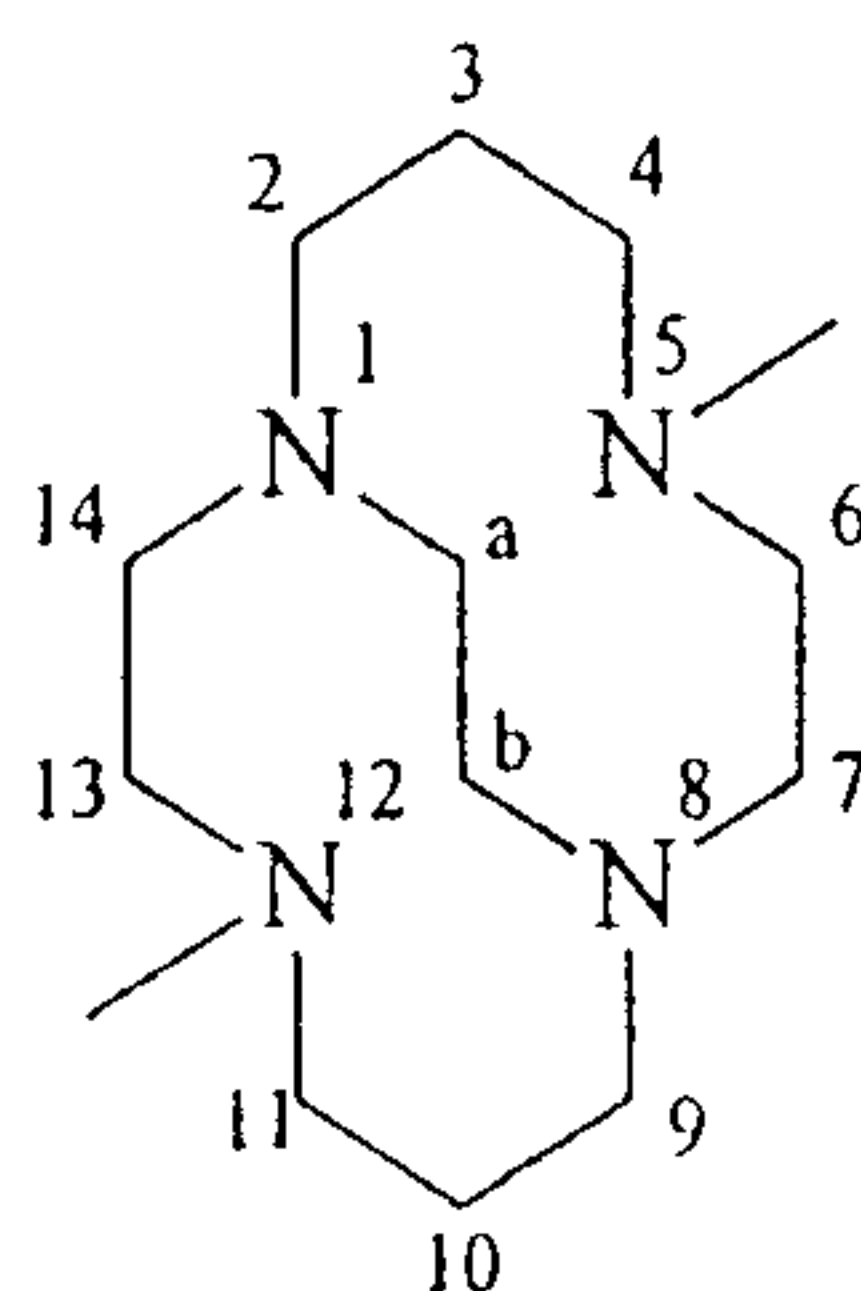
wherein n is an integer, for example from 2 to 8, preferably less than 6, typically 2 to 4, or



wherein m and n are integers from about 1 to 8, more preferably from 1 to 3; Z is N or CH; and T is a compatible substituent, for example H, alkyl, trialkylammonium, halogen, nitro, sulfonate, or the like. The aromatic ring in 1.10 can be replaced by a saturated ring, in which the atom in Z connecting into the ring can contain N, O, S or C.

Suitable MRL's are further nonlimitingly illustrated by the following compound:

101



This is a MRL in accordance with the invention which is a highly preferred, cross-bridged, methyl-substituted (all nitrogen atoms tertiary) derivative of cyclam. Formally, this ligand is named 5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane using the extended von Baeyer system. See "A Guide to IUPAC Nomenclature of Organic Compounds: Recommendations 1993", R. Panico, W.H. Powell and J-C Richer (Eds.), Blackwell Scientific Publications, Boston, 1993; see especially section R-2.4.2.1.

Transition-metal bleach catalysts of Macrocyclic Rigid Ligands which are suitable for use in the invention compositions can in general include known compounds where they conform with the definition herein, as well as, more preferably, any of a large number of novel compounds expressly designed for the present laundry or cleaning uses, and non-limitingly illustrated by any of the following:

Dichloro-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Diaquo-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Hexafluorophosphate

Aquo-hydroxy-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(III)

Hexafluorophosphate

Diaquo-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Tetrafluoroborate

Dichloro-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(III)

Hexafluorophosphate

Dichloro-5,12-di-n-butyl-1,5,8,12-tetraaza bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5,12-dibenzyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-butyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-octyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-butyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II).

As a practical matter, and not by way of limitation, the compositions and cleaning processes herein can be adjusted to provide on the order of at least one part per hundred million of the active bleach catalyst species in the aqueous washing medium, and will preferably provide from about 0.01 ppm to about 25 ppm, more preferably from about 0.05

ppm to about 10 ppm, and most preferably from about 0.1 ppm to about 5 ppm, of the bleach catalyst species in the wash liquor. In order to obtain such levels in the wash liquor of an automatic washing process, typical compositions herein will comprise from about 0.0005% to about 0.2%, more preferably from about 0.004% to about 0.08%, of bleach catalyst, especially manganese or cobalt catalysts, by weight of the bleaching compositions.

(d) Other Bleach Catalysts - The compositions herein may comprise one or more other bleach catalysts. Preferred bleach catalysts are zwitterionic bleach catalysts, which are described in U.S. Patent No. 5,576,282 (especially 3-(3,4-dihydroisoquinolinium) propane sulfonate. Other bleach catalysts include cationic bleach catalysts are described in U.S. Patent Nos. 5,360,569, 5,442,066, 5,478,357, 5,370,826, 5,482,515, 5,550,256, and WO 95/13351, WO 95/13352, and WO 95/13353.

Optional Detergent Enzymes - The detergent and bleaching compositions herein may also optionally contain one or more types of detergent enzymes. Such enzymes can include other proteases, amylases, cellulases and lipases. Such materials are known in the art and are commercially available. They may be incorporated into the non-aqueous liquid detergent compositions herein in the form of suspensions, "marumes" or "prills". Another suitable type of enzyme comprises those in the form of slurries of enzymes in nonionic surfactants, e.g., the enzymes marketed by Novo Nordisk under the trademark "SL" or the microencapsulated enzymes marketed by Novo Nordisk under the trademark "LDP." Suitable enzymes and levels of use are described in U.S. Pat. No. 5,576,282, 5,705,464 and 5,710,115.

Enzymes added to the compositions herein in the form of conventional enzyme prills are especially preferred for use herein. Such prills will generally range in size from about 100 to 1,000 microns, more preferably from about 200 to 800 microns and will be suspended throughout the non-aqueous liquid phase of the composition. Prills in the compositions of the present invention have been found, in comparison with other enzyme forms, to exhibit especially desirable enzyme stability in terms of retention of enzymatic activity over time. Thus, compositions which utilize enzyme prills need not contain conventional enzyme stabilizing such as must frequently be used when enzymes are incorporated into aqueous liquid detergents.

However, enzymes added to the compositions herein may be in the form of granulates, preferably T-granulates.

"Detergent enzyme", as used herein, means any enzyme having a cleaning, stain removing or otherwise beneficial effect in a laundry, hard surface cleaning or personal care detergent composition. Preferred detergent enzymes are hydrolases such as proteases, amylases and lipases. Preferred enzymes for laundry purposes include, but are not limited to, proteases, cellulases, lipases and peroxidases. Highly preferred for automatic

dishwashing are amylases and/or proteases, including both current commercially available types and improved types which, though more and more bleach compatible though successive improvements, have a remaining degree of bleach deactivation susceptibility.

Examples of suitable enzymes include, but are not limited to, hemicellulases, peroxidases, proteases, cellulases, xylanases, lipases, phospholipases, esterases, cutinases, pectinases, keratanases, reductases, oxidases, phenoloxidases, lipoxygenases, ligninases, pullulanases, tannases, pentosanases, malanases, β -glucanases, arabinosidases, hyaluronidase, chondroitinase, laccase, and known amylases, or mixtures thereof.

Examples of such suitable enzymes are disclosed in U.S. Patent Nos. 5,705,464, 5,710,115, 5,576,282, 5,728,671 and 5,707,950

The cellulases useful in the present invention include both bacterial or fungal cellulases. Preferably, they will have a pH optimum of between 5 and 12 and a specific activity above 50 CEVU/mg (Cellulose Viscosity Unit). Suitable cellulases are disclosed in U.S. Patent 4,435,307, J61078384 and WO96/02653 which discloses fungal cellulase produced respectively from *Humicola insolens*, *Trichoderma*, *Thielavia* and *Sporotrichum*. EP 739 982 describes cellulases isolated from novel *Bacillus* species. Suitable cellulases are also disclosed in GB-A-2.075.028; GB-A-2.095.275; DE-OS-2.247.832 and WO95/26398.

Examples of such cellulases are cellulases produced by a strain of *Humicola insolens* (*Humicola grisea* var. *thermoidea*), particularly the *Humicola* strain DSM 1800. Other suitable cellulases are cellulases originated from *Humicola insolens* having a molecular weight of about 50KDa, an isoelectric point of 5.5 and containing 415 amino acids; and a ~43kD endoglucanase derived from *Humicola insolens*, DSM 1800, exhibiting cellulase activity; a preferred endoglucanase component has the amino acid sequence disclosed in WO 91/17243. Also suitable cellulases are the EGIII cellulases from *Trichoderma longibrachiatum* described in WO94/21801 to Genencor. Especially suitable cellulases are the cellulases having color care benefits. Examples of such cellulases are cellulases described in U.S. Patent No. 5,520,838, issued May 28, 1996, (Novo). Carezyme™ and Celluzyme™ (Novo Nordisk A/S) are especially useful. See also WO91/17244 and WO91/21801. Other suitable cellulases for fabric care and/or cleaning properties are described in WO96/34092, WO96/17994 and WO95/24471.

Cellulases, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

Peroxidase enzymes are used in combination with oxygen sources, e.g. percarbonate, perborate, persulfate, hydrogen peroxide, etc and with a phenolic substrate as bleach enhancing molecule. They are used for "solution bleaching", i.e. to prevent transfer of dyes or pigments removed from substrates during wash operations to other substrates in

the wash solution. Peroxidase enzymes are known in the art, and include, for example, horseradish peroxidase, ligninase and haloperoxidase such as chloro- and bromoperoxidase. Suitable peroxidases and peroxidase-containing detergent compositions are disclosed, for example, in U.S. Patent Nos. 5,705,464, 5,710,115, 5,576,282, 5,728,671 and 5,707,950, PCT International Application WO 89/099813, WO89/09813 and in CA Patent Application No. 2,122,987, filed on October 28, 1992 and EP No. 927242 published July 7, 1999. Also suitable is the laccase enzyme.

Enhancers are generally comprised at a level of from 0.1% to 5% by weight of total composition. Preferred enhancers are substituted phenothiazine and phenoxazine 10-Phenothiazinepropionic acid (PPT), 10-ethylphenothiazine-4-carboxylic acid (EPC), 10-phenoxazinepropionic acid (POP) and 10-methylphenoxazine (described in WO 94/12621) and substituted syringates (C3-C5 substituted alkyl syringates) and phenols. Sodium percarbonate or perborate are preferred sources of hydrogen peroxide.

Said peroxidases are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

Enzymatic systems may be used as bleaching agents. The hydrogen peroxide may also be present by adding an enzymatic system (i.e. an enzyme and a substrate therefore) which is capable of generating hydrogen peroxide at the beginning or during the washing and/or rinsing process. Such enzymatic systems are disclosed in EP Patent Application 537381 published April 4, 1993.

Other preferred enzymes that can be included in the cleaning compositions of the present invention include lipases. Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in British Patent 1,372,034. Suitable lipases include those which show a positive immunological cross-reaction with the antibody of the lipase, produced by the microorganism *Pseudomonas fluorescent* IAM 1057. This lipase is available from Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade mark Lipase P "Amano," hereinafter referred to as "Amano-P". Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynth Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. Especially suitable lipases are lipases such as M1 Lipase^R and Lipomax^R (Gist-Brocades) and Lipolase^R and Lipolase Ultra^R(Novo) which have found to be very effective when used in combination with the compositions of the present invention. Also suitable are the lipolytic enzymes described in EP 258 068, WO 92/05249 and WO 95/22615 by Novo Nordisk and in WO 94/03578, WO 95/35381 and WO 96/00292 by Unilever.

Also suitable are cutinases [EC 3.1.1.50] which can be considered as a special kind of lipase, namely lipases which do not require interfacial activation. Addition of cutinases to cleaning compositions have been described in e.g. WO-A-88/09367 (Genencor); WO 90/09446 (Plant Genetic System) and WO 94/14963 and WO 94/14964 (Unilever).

Lipases and/or cutinases, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

In addition to the above referenced lipases, phospholipases may be incorporated into the cleaning compositions of the present invention. Nonlimiting examples of suitable phospholipases included: EC 3.1.1.32 Phospholipase A1; EC 3.1.1.4 Phospholipase A2; EC 3.1.1.5 Lysophospholipase; EC 3.1.4.3 Phospholipase C; EC 3.1.4.4. Phospholipase D. Commercially available phospholipases include LECITASE® from Novo Nordisk A/S of Denmark and Phospholipase A2 from Sigma. When phospholipases are included in the compositions of the present invention, it is preferred that amylases are also included. Without desiring to be bound by theory, it is believed that the combined action of the phospholipase and amylase provide substantive stain removal, especially on greasy/oily, starchy and highly colored stains and soils. Preferably, the phospholipase and amylase, when present, are incorporated into the compositions of the present invention at a pure enzyme weight ratio between 4500:1 and 1:5, more preferably between 50:1 and 1:1.

Suitable proteases are the subtilisins which are obtained from particular strains of *B. subtilis* and *B. licheniformis* (subtilisin BPN and BPN'). One suitable protease is obtained from a strain of *Bacillus*, having maximum activity throughout the pH range of 8-12, developed and sold as ESPERASE® by Novo Industries A/S of Denmark, hereinafter "Novo". The preparation of this enzyme and analogous enzymes is described in GB 1,243,784 to Novo. Proteolytic enzymes also encompass modified bacterial serine proteases, such as those described in European Patent Application 251 446 published January 7, 1988 (particularly pages 17, 24 and 98), and which is called herein "Protease B", and in European Patent Application 199,404, Venegas, published October 29, 1986, which refers to a modified bacterial serine proteolytic enzyme which is called "Protease A" herein. Suitable is the protease called herein "Protease C", which is a variant of an alkaline serine protease from *Bacillus* in which Lysine replaced arginine at position 27, tyrosine replaced valine at position 104, serine replaced asparagine at position 123, and alanine replaced threonine at position 274. Protease C is described in EP 451 244, corresponding to WO 91/06637, Published May 16, 1991. Genetically modified variants, particularly of Protease C, are also included herein.

A preferred protease referred to as "Protease D" is a carbonyl hydrolase as described in U.S. Patent No. 5,677,272, and WO95/10591. Also suitable is a carbonyl

hydrolase variant of the protease described in WO95/10591, having an amino acid sequence derived by replacement of a plurality of amino acid residues replaced in the precursor enzyme corresponding to position +210 in combination with one or more of the following residues : +33, +62, +67, +76, +100, +101, +103, +104, +107, +128, +129, +130, +132, +135, +156, +158, +164, +166, +167, +170, +209, +215, +217, +218, and +222, where the numbered position corresponds to naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins, such as *Bacillus lentus* subtilisin.

Also suitable for the present invention are proteases described in patent applications EP 251 446 and WO 91/06637, protease BLAP[®] described in WO91/02792 and their variants described in WO 95/23221.

See also a high pH protease from *Bacillus* sp. NCIMB 40338 described in WO 93/18140 A to Novo. Enzymatic detergents comprising protease, one or more other enzymes, and a reversible protease inhibitor are described in WO 92/03529 A to Novo. When desired, a protease having decreased adsorption and increased hydrolysis is available as described in WO 95/07791 to Procter & Gamble. A recombinant trypsin-like protease for detergents suitable herein is described in WO 94/25583 to Novo. Other suitable proteases are described in EP 516 200 by Unilever.

Particularly useful proteases are described in PCT publications: WO 95/30010; WO 95/30011; and WO 95/29979. Suitable proteases are commercially available as ESPERASE[®], ALCALASE[®], DURAZYM[®], SAVINASE[®], EVERLASE[®] and KANNASE[®] all from Novo Nordisk A/S of Denmark, and as MAXATASE[®], MAXACAL[®], PROPERASE[®] and MAXAPEM[®] all from Genencor International (formerly Gist-Brocades of The Netherlands).

Such proteolytic enzymes, when present, are incorporated in the cleaning compositions of the present invention a level of from 0.0001% to 2%, preferably from 0.001% to 0.2%, more preferably from 0.005% to 0.1% pure enzyme by weight of the composition.

Amylases (α and/or β) can be included for removal of carbohydrate-based stains. WO94/02597 describes cleaning compositions which incorporate mutant amylases. See also WO95/10603. Other amylases known for use in cleaning compositions include both α - and β -amylases. α -Amylases are known in the art and include those disclosed in US Pat. no. 5,003,257; EP 252,666; WO/91/00353; FR 2,676,456; EP 285,123; EP 525,610; EP 368,341; and British Patent specification no. 1,296,839 (Novo). Other suitable amylases are stability-enhanced amylases described in WO94/18314 and WO96/05295, Genencor, and

amylase variants having additional modification in the immediate parent available from Novo Nordisk A/S, disclosed in WO 95/10603. Also suitable are amylases described in EP 277 216.

Examples of commercial α -amylases products are Purafect Ox Am[®] from Genencor and Termamyl[®], Ban[®], Fungamyl[®] and Duramyl[®], all available from Novo Nordisk A/S Denmark. WO95/26397 describes other suitable amylases : α -amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas[®] α -amylase activity assay. Suitable are variants of the above enzymes, described in WO96/23873 (Novo Nordisk). Other amylolytic enzymes with improved properties with respect to the activity level and the combination of thermostability and a higher activity level are described in WO95/35382.

Such amylolytic enzymes, when present, are incorporated in the cleaning compositions of the present invention a level of from 0.0001% to 2%, preferably from 0.00018% to 0.06%, more preferably from 0.00024% to 0.048% pure enzyme by weight of the composition.

The above-mentioned enzymes may be of any suitable origin, such as vegetable, animal, bacterial, fungal and yeast origin. Origin can further be mesophilic or extremophilic (psychrophilic, psychrotrophic, thermophilic, barophilic, alkalophilic, acidophilic, halophilic, etc.). Purified or non-purified forms of these enzymes may be used. Nowadays, it is common practice to modify wild-type enzymes via protein / genetic engineering techniques in order to optimize their performance efficiency in the laundry detergent and/or fabric care compositions of the invention. For example, the variants may be designed such that the compatibility of the enzyme to commonly encountered ingredients of such compositions is increased. Alternatively, the variant may be designed such that the optimal pH, bleach or chelant stability, catalytic activity and the like, of the enzyme variant is tailored to suit the particular cleaning application.

In particular, attention should be focused on amino acids sensitive to oxidation in the case of bleach stability and on surface charges for the surfactant compatibility. The isoelectric point of such enzymes may be modified by the substitution of some charged amino acids, e.g. an increase in isoelectric point may help to improve compatibility with anionic surfactants. The stability of the enzymes may be further enhanced by the creation of e.g. additional salt bridges and enforcing calcium binding sites to increase chelant stability.

These optional deterative enzymes, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition. The enzymes can be added as separate single ingredients (prills,

granulates, stabilized liquids, etc... containing one enzyme) or as mixtures of two or more enzymes (e.g. cogranulates).

Other suitable detergent ingredients that can be added are enzyme oxidation scavengers. Examples of such enzyme oxidation scavengers are ethoxylated tetraethylene polyamines.

A range of enzyme materials and means for their incorporation into synthetic detergent compositions is also disclosed in WO 9307263 and WO 9307260 to Genencor International, WO 8908694, and U.S. 3,553,139, January 5, 1971 to McCarty et al. Enzymes are further disclosed in U.S. 4,101,457, and in U.S. 4,507,219. Enzyme materials useful for liquid detergent formulations, and their incorporation into such formulations, are disclosed in U.S. 4,261,868.

Enzyme Stabilizers - Enzymes for use in detergents can be stabilized by various techniques. Enzyme stabilization techniques are disclosed and exemplified in U.S. 3,600,319, EP 199,405 and EP 200,586. Enzyme stabilization systems are also described, for example, in U.S. 3,519,570. A useful *Bacillus*, sp. AC13 giving proteases, xylanases and cellulases, is described in WO 9401532. The enzymes employed herein can be stabilized by the presence of water-soluble sources of calcium and/or magnesium ions in the finished compositions which provide such ions to the enzymes. Suitable enzyme stabilizers and levels of use are described in U.S. Pat. Nos. 5,705,464, 5,710,115 and 5,576,282.

Builders - The detergent and bleaching compositions described herein preferably comprise one or more detergent builders or builder systems. When present, the compositions will typically comprise at least about 1% builder, preferably from about 5%, more preferably from about 10% to about 80%, preferably to about 50%, more preferably to about 30% by weight, of detergent builder. Lower or higher levels of builder, however, are not meant to be excluded.

Preferred builders for use in the detergent and bleaching compositions, particularly dishwashing compositions, described herein include, but are not limited to, water-soluble builder compounds, (for example polycarboxylates) as described in U.S. Patent Nos. 5,695,679, 5,705,464 and 5,710,115. Other suitable polycarboxylates are disclosed in U.S. Patent Nos. 4,144,226, 3,308,067 and 3,723,322. Preferred polycarboxylates are hydroxycarboxylates containing up to three carboxy groups per molecule, more particularly titrates.

Inorganic or P-containing detergent builders include, but are not limited to, the alkali metal, ammonium and alkanolammonium salts of polyphosphates (exemplified by the tripolyphosphates, pyrophosphates, and glassy polymeric meta-phosphates), phosphonates (see, for example, U.S. Patent Nos. 3,159,581; 3,213,030; 3,422,021;

3,400,148 and 3,422,137), phytic acid, silicates, carbonates (including bicarbonates and sesquicarbonates), sulphates, and aluminosilicates.

However, non-phosphate builders are required in some locales. Importantly, the compositions herein function surprisingly well even in the presence of the so-called "weak" builders (as compared with phosphates) such as citrate, or in the so-called "underbuilt" situation that may occur with zeolite or layered silicate builders.

Suitable silicates include the water-soluble sodium silicates with an $\text{SiO}_2:\text{Na}_2\text{O}$ ratio of from about 1.0 to 2.8, with ratios of from about 1.6 to 2.4 being preferred, and about 2.0 ratio being most preferred. The silicates may be in the form of either the anhydrous salt or a hydrated salt. Sodium silicate with an $\text{SiO}_2:\text{Na}_2\text{O}$ ratio of 2.0 is the most preferred. Silicates, when present, are preferably present in the detergent and bleaching compositions described herein at a level of from about 5% to about 50% by weight of the composition, more preferably from about 10% to about 40% by weight.

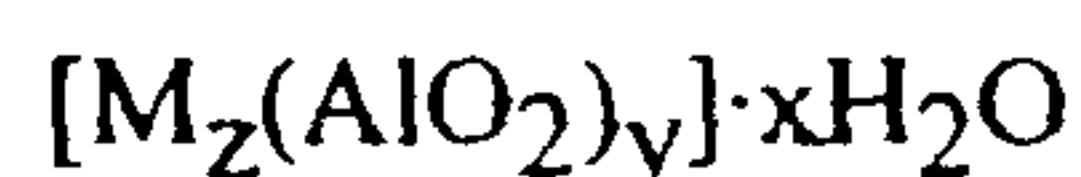
Partially soluble or insoluble builder compounds, which are suitable for use in the detergent and bleaching compositions, particularly granular detergent compositions, include, but are not limited to, crystalline layered silicates, preferably crystalline layered sodium silicates (partially water-soluble) as described in U.S. Patent No. 4,664,839, and sodium aluminosilicates (water-insoluble). When present in detergent and bleaching compositions, these builders are typically present at a level of from about 1% to 80% by weight, preferably from about 10% to 70% by weight, most preferably from about 20% to 60% by weight of the composition.

Crystalline layered sodium silicates having the general formula $\text{NaMSi}_x\text{O}_{2x+1}\cdot y\text{H}_2\text{O}$ wherein M is sodium or hydrogen, x is a number from about 1.9 to about 4, preferably from about 2 to about 4, most preferably 2, and y is a number from about 0 to about 20, preferably 0 can be used in the compositions described herein. Crystalline layered sodium silicates of this type are disclosed in EP-A-0164514 and methods for their preparation are disclosed in DE-A-3417649 and DE-A-3742043. The most preferred material is delta- Na_2SiO_5 , available from Hoechst AG as NaSKS-6 (commonly abbreviated herein as "SKS-6"). Unlike zeolite builders, the Na SKS-6 silicate builder does not contain aluminum. NaSKS-6 has the delta- Na_2SiO_5 morphology form of layered silicate. SKS-6 is a highly preferred layered silicate for use in the compositions described herein, but other such layered silicates, such as those having the general formula $\text{NaMSi}_x\text{O}_{2x+1}\cdot y\text{H}_2\text{O}$ wherein M is sodium or hydrogen, x is a number from 1.9 to 4, preferably 2, and y is a number from 0 to 20, preferably 0 can be used in the compositions described herein. Various other layered silicates from Hoechst include NaSKS-5, NaSKS-7 and NaSKS-11, as the alpha, beta and gamma forms. As noted above, the delta- Na_2SiO_5 (NaSKS-6 form) is most preferred for use herein. Other silicates may

also be useful such as for example magnesium silicate, which can serve as a crispening agent in granular formulations, as a stabilizing agent for oxygen bleaches, and as a component of suds control systems.

The crystalline layered sodium silicate material is preferably present in granular detergent compositions as a particulate in intimate admixture with a solid, water-soluble ionizable material. The solid, water-soluble ionizable material is preferably selected from organic acids, organic and inorganic acid salts and mixtures thereof.

Aluminosilicate builders are of great importance in most currently marketed heavy duty granular detergent compositions, and can also be a significant builder ingredient in liquid detergent formulations. Aluminosilicate builders have the empirical formula:

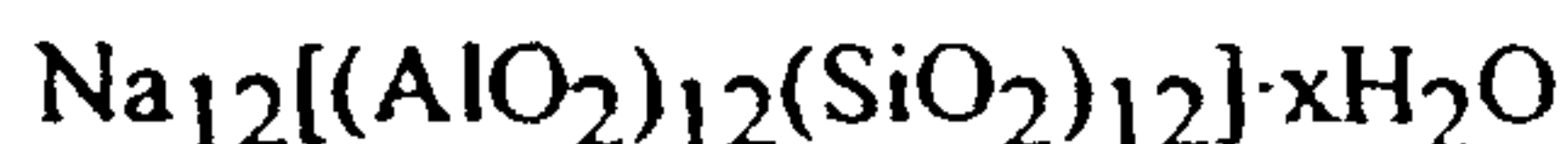


wherein z and y are integers of at least 6, the molar ratio of z to y is in the range from 1.0 to about 0.5, and x is an integer from about 15 to about 264. Preferably, the aluminosilicate builder is an aluminosilicate zeolite having the unit cell formula:



wherein z and y are at least 6; the molar ratio of z to y is from 1.0 to 0.5 and x is at least 5, preferably 7.5 to 276, more preferably from 10 to 264. The aluminosilicate builders are preferably in hydrated form and are preferably crystalline, containing from about 10% to about 28%, more preferably from about 18% to about 22% water in bound form.

These aluminosilicate ion exchange materials can be crystalline or amorphous in structure and can be naturally-occurring aluminosilicates or synthetically derived. A method for producing aluminosilicate ion exchange materials is disclosed in U.S. 3,985,669. Preferred synthetic crystalline aluminosilicate ion exchange materials useful herein are available under the designations Zeolite A, Zeolite B, Zeolite P, Zeolite X, Zeolite MAP and Zeolite HS and mixtures thereof. In an especially preferred embodiment, the crystalline aluminosilicate ion exchange material has the formula:



wherein x is from about 20 to about 30, especially about 27. This material is known as Zeolite A. Dehydrated zeolites ($x = 0 - 10$) may also be used herein. Preferably, the aluminosilicate has a particle size of about 0.1-10 microns in diameter. Zeolite X has the formula:



Citrate builders, e.g., citric acid and soluble salts thereof (particularly sodium salt), are polycarboxylate builders of particular importance for heavy duty liquid detergent formulations due to their availability from renewable resources and their biodegradability. Citrates can also be used in granular compositions, especially in combination with zeolite

and/or layered silicate builders. Oxydisuccinates are also especially useful in such compositions and combinations.

Also suitable in the detergent compositions described herein are the 3,3-dicarboxy-4-oxa-1,6-hexanedioates and the related compounds disclosed in U.S. 4,566,984. Useful succinic acid builders include the C₅-C₂₀ alkyl and alkenyl succinic acids and salts thereof. A particularly preferred compound of this type is dodecenylsuccinic acid. Specific examples of succinate builders include: laurylsuccinate, myristylsuccinate, palmitylsuccinate, 2-dodecenylsuccinate (preferred), 2-pentadecenylsuccinate, and the like. Laurylsuccinates are the preferred builders of this group, and are described in European Patent Application 0,200,263, published November 5, 1986.

Fatty acids, e.g., C₁₂-C₁₈ monocarboxylic acids, can also be incorporated into the compositions alone, or in combination with the aforesaid builders, especially citrate and/or the succinate builders, to provide additional builder activity. Such use of fatty acids will generally result in a diminution of sudsing, which should be taken into account by the formulator.

Dispersants - One or more suitable polyalkyleneimine dispersants may be incorporated into the cleaning compositions of the present invention. Examples of such suitable dispersants can be found in European Patent Application Nos. 111,965, 111,984, and 112,592; U.S. Patent Nos. 4,597,898, 4,548,744, and 5,565,145. However, any suitable clay/soil dispersant or anti-redeposition agent can be used in the laundry compositions of the present invention.

In addition, polymeric dispersing agents which include polymeric polycarboxylates and polyethylene glycols, are suitable for use in the present invention. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarboxylates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers which are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from about 2,000 to 10,000, more preferably from about 4,000 to 7,000 and most preferably from about 4,000 to 5,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble polymers of this type are known materials. Use of polyacrylates of this type in detergent compositions has been disclosed, for example, in U.S. 3,308,067.

Acrylic/maleic-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such

copolymers in the acid form preferably ranges from about 2,000 to 100,000, more preferably from about 5,000 to 75,000, most preferably from about 7,000 to 65,000. The ratio of acrylate to maleate segments in such copolymers will generally range from about 30:1 to about 1:1, more preferably from about 10:1 to 2:1. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble acrylate/maleate copolymers of this type are known materials which are described in European Patent Application No. 66915, published December 15, 1982, as well as in EP 193,360, published September 3, 1986, which also describes such polymers comprising hydroxypropylacrylate. Still other useful dispersing agents include the maleic/acrylic/vinyl alcohol terpolymers. Such materials are also disclosed in EP 193,360, including, for example, the 45/45/10 terpolymer of acrylic/maleic/vinyl alcohol.

Another polymeric material which can be included is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal-antiredeposition agent. Typical molecular weight ranges for these purposes range from about 500 to about 100,000, preferably from about 1,000 to about 50,000, more preferably from about 1,500 to about 10,000.

Polyaspartate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolite builders. Dispersing agents such as polyaspartate preferably have a molecular weight (avg.) of about 10,000.

Soil Release Agents - The compositions according to the present invention may optionally comprise one or more soil release agents. If utilized, soil release agents will generally comprise from about 0.01%, preferably from about 0.1%, more preferably from about 0.2% to about 10%, preferably to about 5%, more preferably to about 3% by weight, of the composition. Nonlimiting examples of suitable soil release polymers are disclosed in: U.S. Patent Nos. 5,728,671; 5,691,298; 5,599,782; 5,415,807; 5,182,043; 4,956,447; 4,976,879; 4,968,451; 4,925,577; 4,861,512; 4,877,896; 4,771,730; 4,711,730; 4,721,580; 4,000,093; 3,959,230; and 3,893,929; and European Patent Application 0 219 048.

Further suitable soil release agents are described in U.S. Patent Nos. 4,201,824; 4,240,918; 4,525,524; 4,579,681; 4,220,918; and 4,787,989; EP 279,134 A; EP 457,205 A; and DE 2,335,044.

Chelating Agents - The compositions of the present invention herein may also optionally contain a chelating agent which serves to chelate metal ions and metal impurities which would otherwise tend to deactivate the bleaching agent(s). Useful chelating agents can include amino carboxylates, phosphonates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures thereof. Further examples of suitable

chelating agents and levels of use are described in U.S. Pat. Nos. 5,705,464, 5,710,115, 5,728,671 and 5,576,282.

The compositions herein may also contain water-soluble methyl glycine diacetic acid (MGDA) salts (or acid form) as a chelant or co-builder useful with, for example, insoluble builders such as zeolites, layered silicates and the like.

If utilized, these chelating agents will generally comprise from about 0.1% to about 15%, more preferably from about 0.1% to about 3.0% by weight of the detergent compositions herein.

Suds suppressor - Another optional ingredient is a suds suppressor, exemplified by silicones, and silica-silicone mixtures. Examples of suitable suds suppressors are disclosed in U.S. Patent Nos. 5,707,950 and 5,728,671. These suds suppressors are normally employed at levels of from 0.001% to 2% by weight of the composition, preferably from 0.01% to 1% by weight.

Softening agents - Fabric softening agents can also be incorporated into laundry detergent compositions in accordance with the present invention. Inorganic softening agents are exemplified by the smectite clays disclosed in GB-A-1 400 898 and in U.S. 5,019,292. Organic softening agents include the water insoluble tertiary amines as disclosed in GB-A-1 514 276 and EP-B-011 340 and their combination with mono C12-C14 quaternary ammonium salts are disclosed in EP-B-026 527 and EP-B-026 528 and di-long-chain amides as disclosed in EP-B-0 242 919. Other useful organic ingredients of fabric softening systems include high molecular weight polyethylene oxide materials as disclosed in EP-A-0 299 575 and 0 313 146.

Particularly suitable fabric softening agents are disclosed in U.S. Patent Nos. 5,707,950 and 5,728,673.

Levels of smectite clay are normally in the range from 2% to 20%, more preferably from 5% to 15% by weight, with the material being added as a dry mixed component to the remainder of the formulation. Organic fabric softening agents such as the water-insoluble tertiary amines or dilong chain amide materials are incorporated at levels of from 0.5% to 5% by weight, normally from 1% to 3% by weight whilst the high molecular weight polyethylene oxide materials and the water soluble cationic materials are added at levels of from 0.1% to 2%, normally from 0.15% to 1.5% by weight. These materials are normally added to the spray dried portion of the composition, although in some instances it may be more convenient to add them as a dry mixed particulate, or spray them as molten liquid on to other solid components of the composition.

Biodegradable quaternary ammonium compounds as described in EP-A-040 562 and EP-A-239 910 have been presented as alternatives to the traditionally used di-long alkyl chain ammonium chlorides and methyl sulfates.

Non-limiting examples of softener-compatible anions for the quaternary ammonium compounds and amine precursors include chloride or methyl sulfate.

Dye transfer inhibition - The detergent compositions of the present invention can also include compounds for inhibiting dye transfer from one fabric to another of solubilized and suspended dyes encountered during fabric laundering and conditioning operations involving colored fabrics.

Polymeric dye transfer inhibiting agents

The detergent compositions according to the present invention can also comprise from 0.001% to 10 %, preferably from 0.01% to 2%, more preferably from 0.05% to 1% by weight of polymeric dye transfer inhibiting agents. Said polymeric dye transfer inhibiting agents are normally incorporated into detergent compositions in order to inhibit the transfer of dyes from colored fabrics onto fabrics washed therewith. These polymers have the ability to complex or adsorb the fugitive dyes washed out of dyed fabrics before the dyes have the opportunity to become attached to other articles in the wash.

Especially suitable polymeric dye transfer inhibiting agents are polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinylpyrrolidone polymers, polyvinylloxazolidones and polyvinylimidazoles or mixtures thereof. Examples of such dye transfer inhibiting agents are disclosed in U.S. Patent Nos. 5,707,950 and 5,707,951.

Additional suitable dye transfer inhibiting agents include, but are not limited to, cross-linked polymers. Cross-linked polymers are polymers whose backbone are interconnected to a certain degree; these links can be of chemical or physical nature, possibly with active groups in the backbone or on branches; cross-linked polymers have been described in the Journal of Polymer Science, volume 22, pages 1035-1039.

In one embodiment, the cross-linked polymers are made in such a way that they form a three-dimensional rigid structure, which can entrap dyes in the pores formed by the three-dimensional structure. In another embodiment, the cross-linked polymers entrap the dyes by swelling.

Addition of such polymers also enhances the performance of the enzymes according to the invention.

pH and Buffering Variation - Many of the detergent and bleaching compositions described herein will be buffered, i.e., they are relatively resistant to pH drop in the presence of acidic soils. However, other compositions herein may have exceptionally low buffering capacity, or may be substantially unbuffered. Techniques for controlling or varying pH at recommended usage levels more generally include the use of not only

buffers, but also additional alkalis, acids, pH-jump systems, dual compartment containers, etc., and are well known to those skilled in the art.

The preferred ADD compositions herein comprise a pH-adjusting component selected from water-soluble alkaline inorganic salts and water-soluble organic or inorganic builders as described in U.S. Patent Nos. 5,705,464 and 5,710,115.

Material Care Agents - The preferred ADD compositions may contain one or more material care agents which are effective as corrosion inhibitors and/or anti-tarnish aids as described in U.S. Patent Nos. 5,705,464, 5,710,115 and 5,646,101.

When present, such protecting materials are preferably incorporated at low levels, e.g., from about 0.01% to about 5% of the ADD composition.

Other Materials - Deterative ingredients or adjuncts optionally included in the instant compositions can include one or more materials for assisting or enhancing cleaning performance, treatment of the substrate to be cleaned, or designed to improve the aesthetics of the compositions. Adjuncts which can also be included in compositions of the present invention, at their conventional art-established levels for use (generally, adjunct materials comprise, in total, from about 30% to about 99.9%, preferably from about 70% to about 95%, by weight of the compositions), include other active ingredients such as non-phosphate builders, color speckles, silvercare, anti-tarnish and/or anti-corrosion agents, dyes, fillers, germicides, alkalinity sources, hydrotropes, anti-oxidants, perfumes, solubilizing agents, carriers, processing aids, pigments, and pH control agents as described in U.S. Patent Nos. 5,705,464, 5,710,115, 5,698,504, 5,695,679, 5,686,014 and 5,646,101.

Methods of Cleaning - In addition to the methods for cleaning fabrics, dishes and other hard surfaces, and body parts by personal cleansing, described herein, the invention herein also encompasses a laundering pretreatment process for fabrics which have been soiled or stained comprising directly contacting said stains and/or soils with a highly concentrated form of the bleaching composition set forth above prior to washing such fabrics using conventional aqueous washing solutions. Preferably, the bleaching composition remains in contact with the soil/stain for a period of from about 30 seconds to 24 hours prior to washing the pretreated soiled/stained substrate in conventional manner. More preferably, pretreatment times will range from about 1 to 180 minutes.

The following examples are meant to exemplify compositions of the present invention, but are not necessarily meant to limit or otherwise define the scope of the invention.

In all of the following examples Protease¹ means a protease variant comprising substitution of amino acid residues with another naturally occurring amino acid residue at positions corresponding to positions 101G/103A/104I/159D/232V/236H/245R/248D/252K of *Bacillus amyloliquefaciens* subtilisin. Protease¹ can be substituted with any other

additional protease variant of the present invention, with substantially similar results in the following examples.

In the cleaning composition examples of the present invention, the Protease¹ enzyme levels are expressed by pure enzyme by weight of the total composition, the other enzyme levels are expressed by raw material by weight of the total composition, and unless otherwise specified, the other ingredients are expressed by weight of the total composition.

Further, in the following examples some abbreviations known to those of ordinary skill in the art are used, consistent with the disclosure set forth herein.

Example 1

Granular Automatic Dishwashing Composition

<u>Component</u>	<u>A</u>	<u>B</u>	<u>C</u>
Citric Acid	15.0	-	-
Citrate	4.0	29.0	15.0
Acrylate/methacrylate copolymer	6.0	-	6.0
Acrylic acid maleic acid copolymer	-	3.7	-
Dry add carbonate	9.0	-	20.0
Alkali metal silicate	8.5	17.0	9.0
Paraffin	-	0.5	-
Benzotriazole	-	0.3	-
Termamyl 60T TM	1.6	1.6	1.6
Protease ¹	0.2	0.1	0.06
Percarbonate (AvO)	1.5	-	-
Perborate monohydrate	-	0.3	1.5
Perborate tetrahydrate	-	0.9	-
NOBS	-	-	2.40
TAED	3.8	4.4	-
Diethylene triamine penta methyl phosphonic acid (Mg salt)	0.13	0.13	0.13
Alkyl ethoxy sulphate - 3 times ethoxylated	3.0	-	-
Alkyl ethoxy propoxy nonionic surfactant	-	1.5	-
Suds suppressor	2.0	-	-
Olin SLF 18 nonionic surfactant TM	-	-	2.0
Sulfate (Balance 100%)			

Example 2

Compact high density (0.96Kg/l) dishwashing detergent compositions A to F in accordance with the invention:

Component	A	B	C	D	E	F
STPP	-	51.4	51.4	-	-	44.3
Citrate	17.05	-	-	49.6	40.2	-
Carbonate	17.50	14.0	20.0		8.0	33.6
Bicarbonate	-	-	-	26.0	-	-
Silicate	14.81	15.0	8.0	-	25.0	3.6
Metasilicate	2.50	4.5	4.5	-	-	-
PB1	9.74	7.79	7.79	-	-	-
PB4	-	-	-	9.6	-	-
Percarbonate	-	-	-	-	11.8	4.8
Nonionic	2.00	1.50	1.50	2.6	1.9	5.9
TAED	2.39	-	-	3.8	-	1.4
HEDP	1.00	-	-	-	-	-
DETPMP	0.65	-	-	-	-	-
Mn TACN	-	-	-	-	0.008	-
NOBS	-	2.40	-	-	-	-
PAAC	-	-	0.008	-	-	-
Paraffin	0.50	0.38	0.38	0.6	-	-
Protease ¹	0.1	0.06	0.05	0.03	0.07	0.01
Amylase	1.5	1.5	1.5	2.6	2.1	0.8
BTA	0.30	0.22	0.22	0.3	0.3	0.3
Polycarboxylate	6.0	-	-	-	4.2	0.9
Perfume	0.2	0.12	0.12	0.2	0.2	0.2
Sulfate / Water	20.57	1.97	2.97	3.6	4.5	3.9
pH (1% solution)	11.0	11.0	11.3	9.6	10.8	10.9

Example 3

Granular dishwashing detergent compositions examples A to F of bulk density 1.02Kg/L in accordance with the invention:

Component	A	B	C	D	E	F
STPP	30.00	33.5	27.9	29.62	33.8	22.0
Carbonate	30.50	30.50	30.5	23.00	34.5	45.0
Silicate	7.40	7.50	12.6	13.3	3.2	6.2

Metasilicate	-	4.5				
Percarbonate	-	-		-	4.0	
PBI	4.4	4.5	4.3	-	-	
NaDCC	-	-		2.00	-	0.9
Nonionic	1.0	0.75	1.0	1.90	0.7	0.5
TAED	1.00	-		-	-	
NOBS	-	-	-	-	2.0	-
PAAC	-	0.004		-	-	
Paraffin	0.25	0.25		-	-	
Protease ¹	0.05	0.06	0.025	0.1	0.02	0.07
Amylase	0.38	0.64	0.46	-	0.6	
BTA	0.15	0.15		-	0.2	
Perfume	0.2	0.2	0.05	0.1	0.2	
Sulfate/water	23.45	16.87	22.26	30.08	21.7	25.4
pH (1% solution)	10.80	11.3	11.0	10.70	11.5	10.9

Example 4

Tablet detergent composition examples A to H in accordance with the present invention are prepared by compression of a granular dishwashing detergent composition at a pressure of 13KN/cm² using a standard 12 head rotary press:

Component	A	B	C	D	E	F	G	H
STPP	-	48.8	54.7	38.2	-	52.4	56. 1	36. 0
Citrate	20.0	-	-	-	35.9	-	-	-
Carbonate	20.0	5.0	14.0	15.4	8.0	23.0	20. 0	28. 0
Silicate	15.0	14.8	15.0	12.6	23.4	2.9	4.3	4.2
Protease ¹	0.05	0.09	0.05	0.03	0.06	0.03	0.0 3	0.1
Amylase	1.5	1.5	1.5	0.85	1.9	0.4	2.1	0.3
PBI	14.3	7.8	11.7	12.2	-	-	6.7	8.5
PB4	-	-	-	-	22.8	-	3.4	-
Percarbonate	-	-	-	-	-	10.4	-	-
Nonionic	1.5	2.0	2.0	2.2	1.0	4.2	4.0	6.5
PAAC	-	-	0.016	0.009	-	-	-	-
MnTACN	-	-	-	-	0.007	-	-	-

TAED	2.7	2.4	-	-	-	2.1	0.7	1.6
HEDP	1.0	-	-	0.93	-	0.4	0.2	-
DETPMP	0.7	-	-	-	-	-	-	-
Paraffin	0.4	0.5	0.5	0.55	-	-	0.5	-
BTA	0.2	0.3	0.3	0.33	0.3	0.3	0.3	-
Polycarboxylate	4.0	-	-	-	4.9	0.6	0.8	-
PEG	-	-	-	-	-	2.0	-	2.0
Glycerol	-	-	-	-	-	0.4	-	0.5
Perfume	-	-	-	0.05	0.20	0.2	0.2	0.2
Sulfate / water	17.4	14.7	-	15.74	-	-	-	11. 3
weight of tablet	20g	25g	20g	30g	18g	20g	25g	24. 0
pH (1% solution)	10.7	10.6 0	10.7	10.7	10.9	11.2	11. 0	10. 8

Examples 5Granular Fabric Cleaning CompositionsComponentsExample No.

A B

Linear alkyl benzene sulphonate	11.4	10.70
Tallow alkyl sulphate	1.80	2.40
C ₁₄₋₁₅ alkyl sulphate	3.00	3.10
C ₁₄₋₁₅ alcohol 7 times ethoxylated	4.00	4.00
Tallow alcohol 11 times ethoxylated	1.80	1.80
Dispersant	0.07	0.1
Silicone fluid	0.80	0.80
Trisodium citrate	14.00	15.00
Citric acid	3.00	2.50
Zeolite	32.50	32.10
Maleic acid acrylic acid copolymer	5.00	5.00

120

Diethylene triamine penta methylene phosphonic acid	1.00	0.20
Protease ¹	0.1	0.01
Lipase	0.36	0.40
Amylase	0.30	0.30
Sodium silicate	2.00	2.50
Sodium sulphate	3.50	5.20
Polyvinyl pyrrolidone	0.30	0.50
Perborate	0.5	1
TAED	1.0	-
NOBS	-	1.0
Phenol sulphonate	0.1	-
Peroxidase	0.1	0.1
Minors	Up to 100	Up to 100

Examples 6Granular Fabric Cleaning Compositions

<u>Components</u>	<u>Example No.</u>	
	<u>A</u>	<u>B</u>
Sodium linear C ₁₂ alkyl benzene-sulfonate	6.5	8.0
Sodium sulfate	15.0	18.0
Zeolite A	26.0	22.0
Sodium nitrilotriacetate	5.0	5.0
Polyvinyl pyrrolidone	0.5	0.7
TAED	3.0	-
NOBS	-	2.4
Boric acid	4.0	-
Perborate	0.5	1
Phenol sulphonate	0.1	-
Protease ¹	0.02	0.05

Fillers (e.g., silicates; carbonates; perfumes; water)	Up to 100	Up to 100
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Example 7Compact Granular Fabric Cleaning Composition

<u>Components</u>	<u>Weight %</u>
Alkyl Sulphate	8.0
Alkyl Ethoxy Sulphate	2.0
Mixture of C25 and C45 alcohol 3 and 7 times ethoxylated	6.0
Polyhydroxy fatty acid amide	2.5
Zeolite	17.0
Layered silicate/citrate	16.0
Carbonate	7.0
Maleic acid acrylic acid copolymer	5.0
Soil release polymer	0.4
Carboxymethyl cellulose	0.4
Poly (4-vinylpyridine) -N-oxide	0.1
Copolymer of vinylimidazole and vinylpyrrolidone	0.1
PEG2000	0.2
Protease ¹	0.03
Lipase	0.2
Cellulase	0.2
TAED	6.0
Percarbonate	22.0
Ethylene diamine disuccinic acid	0.3
Suds suppressor	3.5
Disodium-4,4'-bis (2-morpholino -4-anilino-s-triazin-6-ylamino) stilbene-2,2'-disulphonate	0.25
Disodium-4,4'-bis (2-sulfostyryl) biphenyl	0.05
Water, Perfume and Minors	Up to 100

Example 8Granular Fabric Cleaning Composition

<u>Component</u>	<u>Weight %</u>
Linear alkyl benzene sulphonate	7.6
C ₁₆ -C ₁₈ alkyl sulfate	1.3

C ₁₄₋₁₅ alcohol 7 times ethoxylated	4.0
Coco-alkyl-dimethyl hydroxyethyl ammonium chloride	1.4
Dispersant	0.07
Silicone fluid	0.8
Trisodium citrate	5.0
Zeolite 4A	15.0
Maleic acid acrylic acid copolymer	4.0
Diethylene triamine penta methylene phosphonic acid	0.4
Perborate	15.0
TAED	5.0
Smectite clay	10.0
Poly (oxy ethylene) (MW 300,000)	0.3
Protease ¹	0.02
Lipase	0.2
Amylase	0.3
Cellulase	0.2
Sodium silicate	3.0
Sodium carbonate	10.0
Carboxymethyl cellulose	0.2
Brighteners	0.2
Water, perfume and minors	Up to 100

Example 9

Granular Fabric Cleaning Composition

<u>Component</u>	<u>Weight %</u>
Linear alkyl benzene sulfonate	6.92
Tallow alkyl sulfate	2.05
C ₁₄₋₁₅ alcohol 7 times ethoxylated	4.4
C ₁₂₋₁₅ alkyl ethoxy sulfate - 3 times ethoxylated	0.16
Zeolite	20.2
Citrate	5.5
Carbonate	15.4
Silicate	3.0

Maleic acid acrylic acid copolymer	4.0
Carboxymethyl cellulase	0.31
Soil release polymer	0.30
Protease ¹	0.1
Lipase	0.36
Cellulase	0.13
Perborate tetrahydrate	11.64
Perborate monohydrate	8.7
TAED	5.0
Diethylene tramine penta methyl phosphonic acid	0.38
Magnesium sulfate	0.40
Brightener	0.19
Perfume, silicone, suds suppressors	0.85
Minors	Up to 100

Example 10Granular Fabric Cleaning Composition

<u>Component</u>	<u>A</u>	<u>B</u>	<u>C</u>
Base Granule Components			
LAS/AS/AES (65/35)	9.95	-	-
LAS/AS/AES (70/30)	-	12.05	7.70
Alumino silicate	14.06	15.74	17.10
Sodium carbonate	11.86	12.74	13.07
Sodium silicate	0.58	0.58	0.58
NaPAA Solids	2.26	2.26	1.47
PEG Solids	1.01	1.12	0.66
Brighteners	0.17	0.17	0.11
DTPA	-	-	0.70
Sulfate	5.46	6.64	4.25
DC-1400 Deaerant	0.02	0.02	0.02
Moisture	3.73	3.98	4.33
Minors	0.31	0.49	0.31

B.O.T. Spray-on

Nonionic surfactant	0.50	0.50	0.50
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Agglomerate Components

LAS/AS (25/75)	11.70	9.60	10.47
Alumino silicate	13.73	11.26	12.28
Carbonate	8.11	6.66	7.26
PEG 4000	0.59	0.48	0.52
Moisture/Minors	4.88	4.00	4.36

Functional Additives

Sodium carbonate	7.37	6.98	7.45
Perborate	1.03	1.03	2.56
AC Base Coating	-	1.00	-
NOBS	-	-	2.40
Soil release polymer	0.41	0.41	0.31
Cellulase	0.33	0.33	0.24
Protease ¹	0.1	0.05	0.15
AE-Flake TM	0.40	0.40	0.29

Liquid Spray-on

Perfume	0.42	0.42	0.42
Noionic spray-on	1.00	1.00	0.50
Minors		Up to 100	

Example 11Granular Fabric Cleaning Composition

	A	B
Surfactant		
- Na LAS	6.40	-
- KLAS	-	9.90
- AS/AE3S	6.40	4.39
- TAS	0.08	0.11
- C24AE5	3.48	-
- Genagen TM	-	1.88
- N-cocoyl N-methyl glucamine (lin)	1.14	2.82

125

- C ₈₋₁₀ dimethyl hydroxyethyl ammonium chloride	1.00	1.40
Builder		
- Zeolite	20.59	13.39
- SKS-6	10.84	10.78
- Citric Acid	2.00	-
Buffer		
- Carbonate	9.60	12.07
- Bicarbonate	2.00	2.00
- Sulphate	2.64	-
- Silicate	0.61	0.16
Polymer		
- Acrylic acid/maleic acid copolymer (Na)	1.17	1.12
- CMC	0.45	0.24
- Polymer	0.34	0.18
- Hexamethylene- diamine tetra-E24 ethoxylate, diquaternized with methyl chloride	1.00	1.00
Enzyme		
- Protease ¹ (% pure enzyme)	0.03	0.03
- Cellulase	0.26	0.26
- Amylase	0.65	0.73
- Lipase	0.27	0.15
Bleach		
- TAED (100%)	3.85	3.50
- Phenolsulfonate ester of N-nonanoyl-6- aminocaproic acid	-	2.75
- Percarbonate	16.20	18.30
- HEDP	0.48	0.48
- EDDS	0.30	0.30
Miscellaneous		

126

- Malic particle		2.20 + bicarb
- Brightener 15/49	0.077/0.014	0.07/0.014
- Zinc phthalocyanine sulfonate	0.0026	0.0026
- Polydimethylsiloxane with trimethylsilyl end blocking units	0.25	0.24
- Soap	-	1.00
- Perfume	0.45	0.55
TOTAL	100	100

Example 12Granular Fabric Cleaning Composition

	A	B
Surfactant		
NaLAS	6.8	0.4
KLAS	-	10.9
FAS	0.9	0.1
AS	0.6	1.5
C25AE3S	0.1	-
AE5	4.2	-
N-Cocoyl-N-Methyl Glucamine	-	1.8
Genagen	-	1.2
C8-10 dimethyl hydroxyethyl ammonium chloride	-	1.0
Builder		
SKS-6	3.3	9.0
Zeolite	17.2	18.9
Citric Acid	1.5	-
Buffer		
Carbonate	21.1	15.0
Sodium Bicarbonate	-	2.6
Sulphate	15.2	5.5
Malic Acid	-	2.9
Silicate	0.1	-
Polymer		

127

Acrylic acid/maleic acid copolymer (Na)	2.2	0.9
Hexamethylene-diamine tetra-E24 ethoxylate, diquaternized with methyl chloride	0.5	0.7
Polymer	0.1	0.1
CMC	0.2	0.1
Enzymes		
Protease ¹ (% pure enzyme)	0.02	0.05
Lipase	0.18	0.14
Amylase	0.64	0.73
Cellulase	0.13	0.26
Bleach		
TAED	2.2	2.5
Phenolsulfonate ester of N-nonanoyl-6-aminocaproic acid	-	1.96
Sodium Percarbonate	-	13.1
PB4	15.6	-
EDDS	0.17	0.21
MgSO ₄	0.35	0.47
HEDP	0.15	0.34
Brightener	0.06	0.04
- Zinc phthalocyanine sulfonate	0.0015	0.0020
- Polydimethylsiloxane with trimethylsilyl end blocking units	0.04	0.14
Soap	0.5	0.7
Perfume	0.35	0.45
Speckle	0.5	0.6

Examples 13

Granular laundry detergent compositions 13 A-C in accordance with the present invention are of particular utility under European machine wash conditions:

Component	A	B	C
LAS	7.0	5.61	4.76
TAS	-	-	1.57

128

C45AS	6.0	2.24	3.89
C25E3S	1.0	0.76	1.18
C45E7	-	-	2.0
C25E3	4.0	5.5	-
QAS	0.8	2.0	2.0
STPP	-	-	-
Zeolite A	25.0	19.5	19.5
Citric acid	2.0	2.0	2.0
NaSKS-6	8.0	10.6	10.6
Carbonate I	8.0	10.0	8.6
MA/AA	1.0	2.6	1.6
CMC	0.5	0.4	0.4
PB4	-	12.7	-
Percarbonate	-	-	19.7
TAED	-	3.1	5.0
Citrate	7.0	-	-
DTPMP	0.25	0.2	0.2
HEDP	0.3	0.3	0.3
QEA 1	0.9	1.2	1.0
Protease ¹	0.02	0.05	0.035
Lipase	0.15	0.25	0.15
Cellulase	0.28	0.28	0.28
Amylase	0.4	0.7	0.3
PVPI/ PVNO	0.4	-	0.1
Photoactivated bleach (ppm)	15 ppm	27 ppm	27 ppm
Brightener 1	0.08	0.19	0.19
Brightener 2	-	0.04	0.04

Perfume	0.3	0.3	0.3
<u>Effervescent granules</u> (malic acid 40%, sodium bicarbonate 40%, sodium carbonate 20%)	15	15	5
Silicone antifoam	0.5	2.4	2.4
Minors/inerts to 100%			

Example 14

The following formulations are examples of compositions in accordance with the invention, which may be in the form of granules or in the form of a tablet.

Component	14
C45 AS/TAS	3.0
LAS	8.0
C25AE3S	1.0
NaSKS-6	9.0
C25AE5/AE3	5.0
Zeolite A	10.0
SKS-6 (I) (dry add)	2.0
MA/AA	2.0
Citric acid	1.5
EDDS	0.5
HEDP	0.2
PBI	10.0
NACA OBS	2.0
TAED	2.0
Carbonate	8.0
Sulphate	2.0
Amylase	0.3
Lipase	0.2
Protease ¹	0.02
Minors (Brightener/SRP1/ CMC/Photobleach/ MgSO4/ PVPVI/Suds suppressor/ PEG)	0.5

130

Perfume	0.5
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Example 15Liquid Fabric Cleaning Compositions

<u>Component</u>	<u>Example No.</u>	
	<u>A</u>	<u>B</u>
C ₁₂₋₁₄ alkenyl succinic acid	3.0	8.0
Citric acid monohydrate	10.0	15.0
Sodium C ₁₂₋₁₅ alkyl sulphate	8.0	8.0
Sodium sulfate of C ₁₂₋₁₅ alcohol 2 times ethoxylated	-	3.0
C ₁₂₋₁₅ alcohol 7 times ethoxylated	-	8.0
C ₁₂₋₁₅ alcohol 5 times ethoxylated	8.0	-
Diethylene triamine penta (methylene phosphonic acid)	0.2	-
Oleic acid	1.8	-
Ethanol	4.0	4.0
Propanediol	2.0	2.0
Protease ¹	0.01	0.02
Suds suppressor	0.15	0.15
NaOH	up to pH 7.5	
Perborate	0.5	1
Phenol sulphonate	0.1	0.2
Peroxidase	0.4	0.1
Waters and minors	up to 100 %	

Example 16Liquid Fabric Cleaning Compositions

<u>Component</u>	<u>Example No.</u>
NaLAS (100%am)	17
Neodol TM	16
EDDS	21.5
Dispersant	1.2
Perborate	1.3
Phenolsulfonate ester of N-nonanoyl-6-aminocaproic acid	12
Protease ¹ (% pure enzyme)	6
	0.03

131

Cellulase	0.03
Solvent (BPP)	18.5
Polymer	0.1
Carbonate	10
FWA 15	0.2
TiO ₂	0.5
PEG 8000	0.4
Perfume	1.0-1.2
Suds suppressor	0.06
Waters and minors	up to 100%

Example 17Two-layer Effervescent Denture Cleansing Tablet

Component	Example No.			
	A	B	C	D
<u>Acidic Layer</u>				
Protease ¹	1.0	1.5	0.01	0.05
Tartaric acid	24.0	24.0	24.00	24.00
Sodium carbonate	4.0	4.0	4.00	4.00
Sulphamic acid	10.0	10.0	10.00	10.00
PEG 20,000	4.0	4.0	4.00	4.00
Sodium bicarbonate	24.5	24.5	24.50	24.50
Potassium persulfate	15.0	15.0	15.00	15.00
Sodium acid pyrophosphate	7.0	7.0	7.00	7.00
Pyrogenic silica	2.0	2.0	2.00	2.00
Tetracetylene diamine	7.0	7.0	7.00	7.00
Flavor	1.0	1.0	1.00	1.00
<u>Alkaline Layer</u>				
Sodium perborate monohydrate	32.0	32.0	32.00	32.00
Sodium bicarbonate	19.0	19.0	19.00	19.00
EDTA	3.0	3.0	3.00	3.00
Sodium tripolyphosphate	12.0	12.0	12.00	12.00
PEG 20,000	2.0	2.0	2.00	2.00

Sodium carbonate	2.0	2.0	2.00	2.00
Pyrogenic silica	2.0	2.0	2.00	2.00
Dye/flavor	2.0	2.0	2.00	2.00

Example 18

Granular laundry detergent compositions 18 A-E are of particular utility under Japanese machine wash conditions and are prepared in accordance with the invention:

Component	A	B	C	D	E
LAS	23.57	23.57	21.67	21.68	21.68
FAS	4.16	4.16	3.83	3.83	3.83
Nonionic surfactant	3.30	3.30	2.94	3.27	3.27
Bis (hydroxyethyl) methyl alkyl ammonium chloride	0.47	0.47	1.20	1.20	1.20
SKS-6	7.50	7.50	5.17	5.76	5.06
Polyacrylate copolymer (MW 11000) (maleic/acrylate ratio of 4:6)	7.03	7.03	14.36	14.36	14.36
Zeolite	11.90	11.40	10.69	11.34	11.34
Carbonate	14.90	14.82	11.71	11.18	11.18
Silicate	12.00	12.00	12.37	12.38	12.38
Protease ¹	0.016	0.016	0.046	0.046	0.046
Lipase	-	-	0.28	-	-
Amylase	-	-	0.62	-	-
Cellulase	-	-	0.48	-	0.70
NOBS	3.75	3.75	2.70	2.70	2.70

PB1	3.53	-	2.60	-	-
Sodium percarbonate	-	4.21	-	3.16	3.16
SRP	0.52	0.52	0.70	0.70	0.70
Brightener	0.31	0.31	0.28	0.28	0.50
AE-coflake	0.17	0.20	0.17	0.17	0.17
Polydimethylsiloxane	-	-	0.68	0.68	0.68
Perfume	0.06	0.06	0.08	-	-
Perfume	-	-	-	0.23	0.23
Hydrophobic precipitated silica	0.30	0.30	0.30	0.30	0.30
PEG4000	0.19	0.19	0.17	0.17	0.17
Minors/inerts to 100%					

While particular embodiments of the subject invention have been described, it will be obvious to those skilled in the art that various changes and modifications of the subject invention can be made without departing from the spirit and scope of the invention. It is intended to cover, in the appended claims, all such modifications that are within the scope of the invention.

The compositions of the present invention can be suitably prepared by any process chosen by the formulator, non-limiting examples of which are described in U.S. Patent Nos. 5,691,297; 5,574,005; 5,569,645; 5,565,422; 5,516,448; 5,489,392; and 5,486,303.

In addition to the above examples, the bleaching compositions of the present invention can be formulated into any suitable laundry detergent composition, non-limiting examples of which are described in U.S. Patent Nos. 5,679,630; 5,565,145; 5,478,489; 5,470,507; 5,466,802; 5,460,752; 5,458,810; 5,458,809; and 5,288,431.

Having described the invention in detail with reference to preferred embodiments and the examples, it will be clear to those skilled in the art that various changes and modifications may be made without departing from the scope of the invention and the invention is not to be considered limited to what is described in the specification.

CLAIMS:

1. A bleaching composition comprising:
 - (a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 230 and 232 of
5 *Bacillus amyloliquefaciens* subtilisin;
 - (b) a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and
 - 10 (c) one or more cleaning adjunct materials.
2. The bleaching composition according to Claim 1 wherein said protease variant is derived from a *Bacillus* subtilisin.
- 15 3. The bleaching composition according to Claim 1 wherein said protease variant includes substitutions of the amino acid residues at one or more of the following positions selected from the group consisting of:
 - 1) position 230 and at one or more of the following positions 68, 103, 104, 159, 232, 236 and 245;
 - 20 2) position 232 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
 - 3) position 232 and at one or more of the following positions 103, 104, 236 and 245;
 - 25 4) positions 232 and 103 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
 - 5) positions 232 and 104 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
 - 30 6) positions 232 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
 - 7) positions 232 and 245 and at one or more of the following positions 12, 61, 62, 35 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

8) positions 232, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275.

- 5 4. The bleaching composition according to Claim 1 wherein said protease variant includes a substitution set selected from the group consisting of:
- 12/102/103/104/159/212/232/236/245/248/252; 61/68/103/104/159/232/236/245/248/252;
 62/103/104/130/159/213/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
 62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
 10 62/101/103/104/159/212/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252/270;
 68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
 68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
 68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
 15 68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
 68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
 68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
 68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
 20 68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
 68/76/103/104/159/213/232/236/245/260; 68/76/103/104/159/210/232/236/245/260;
 68/103/104/159/183/232/236/245/248/252; 68/103/104/232/236/245/257/275;
 68/103/104/159/213/232/236/245; 76/103/104/159/232/236/245;
 76/103/104/159/213/232/236/245/260; 76/103/104/131/159/232/236/245/248/252;
 25 97/103/104/159/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
 98/102/103/104/159/212/232/236/245/248/252; 101/103/104/159/232/236/245/248/252;
 102/103/104/159/232/236/245/248/252; 103/104/159/232/236/245;
 103/104/159/232/236/245/248/252;
 103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;
 30 103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
 103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
 103/104/131/159/232/236/245/248/252; 103/104/159/205/209/232/236/245; and
 103/104/159/232/236/245/257.

- 35 5. The bleaching composition according to Claim 4 wherein said protease variant includes a substitution set selected from the group consisting of:

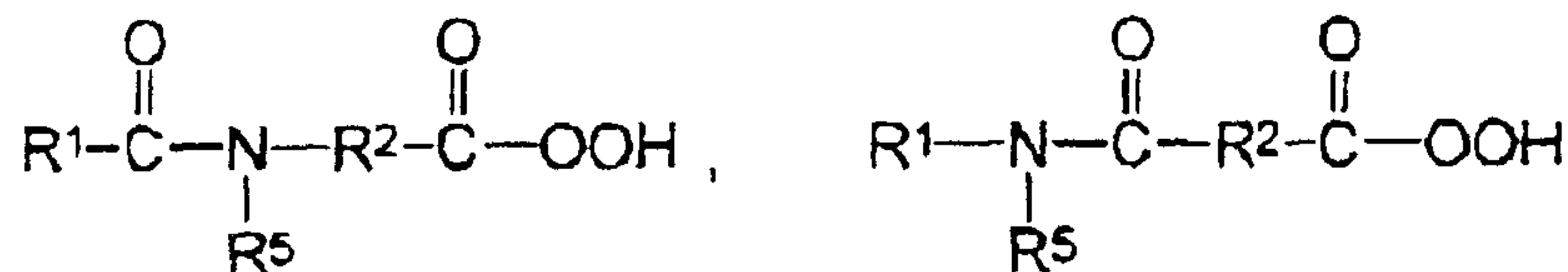
12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;

61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/232V/236H/245R/248D/252K;
5 62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
10 68A/103A/104I/159D/209W/232V/236H/245R;
68A/76D/103A/104I/159D/211R/232V/236H/245R;
68A/76D/103A/104I/159D/215R/232V/236H/245R;
68A/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/232V/236H/245R;
15 68A/103A/104I/159D/232V/236H/245R/252K;
68A/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/257V;
68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
20 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/230V/232V/236H/245R;
68A/76D/103A/104I/159D/209W/232V/236H/245R;
68A/103A/104I/232V/236H/245R/248D/257V/275H;
25 68A/103A/104I/232V/236H/245R/257V/275H;
68A/103A/104I/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210I/232V/236H/245R;
68A/103A/104I/159D/210L/232V/236H/245R;
30 68A/103A/104I/159D/213G/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
35 97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;
98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;

101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K;
 5 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R;
 103A/104I/159D/205I/209W/232V/236H/245R;
 103A/104I/159D/232V/236H/245R/257V;
 10 103A/104I/159D/205I/209W/232V/236H/245R/257V;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
 103A/104I/159D/232V/245R/248D/252K.

15 6. The bleaching composition according to Claim 1 wherein said bleaching agent is selected from the group consisting of:

(i) an organic peroxyacid selected from the group consisting of organic peroxyacids of the formula:



20 wherein R^1 is an alkyl, aryl, or alkaryl group containing from 1 to 14 carbon atoms, R^2 is an alkylene, arylene or alkarylene group containing from 1 to 14 carbon atoms, and R^5 is H or an alkyl, aryl, or alkaryl group containing from 1 to 10 carbon atoms; E-phthalimido peroxypropionic acids; and mixtures thereof; and

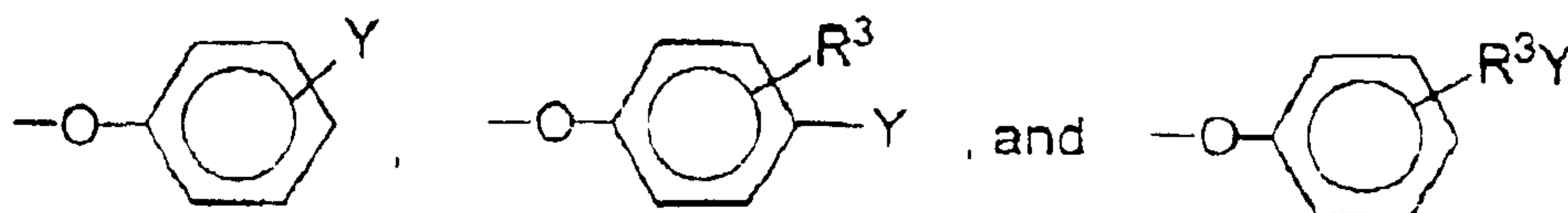
25 (ii) a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition, wherein said bleach activator has the general formula:



wherein R is an alkyl group containing from 5 to 18 carbon atoms wherein the longest linear alkyl chain extending from and including the carbonyl carbon contains from 6 to 10 carbon atoms and L is a leaving group, the conjugate acid of which has a pKa in the range of from 4 to 13.

5

- 10 7. The bleaching composition according to Claim 6 wherein R^1 is an alkyl group containing from 7 to 10 carbon atoms, R^2 contains from 4 to 5 carbon atoms, and wherein L is selected from the group consisting of:



- 15 wherein R^3 is an alkyl chain containing from 1 to 8 carbon atoms, and Y is $-SO_3^-M^+$ or $-CO_2^-M^+$ wherein M is sodium or potassium.

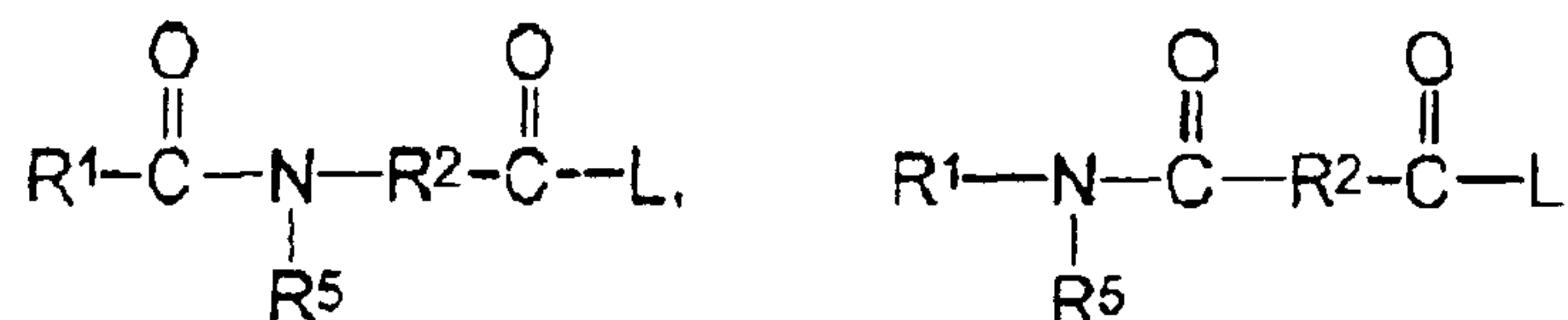
8. The bleaching composition according to Claim 1 wherein said bleaching agent comprises a bleach activator selected from the group consisting of tetraacetyl ethylene diamine (TAED), benzoylcaprolactam (BzCL), 4-nitrobenzoylcaprolactam, 3-chlorobenzoylcaprolactam, benzoyloxybenzenesulphonate (BOBS), nonanoyloxybenzenesulphonate (NOBS), phenyl benzoate (PhBz), decanoyloxybenzenesulphonate (C₁₀-OBS), benzoylvalerolactam (BZVL), octanoyloxybenzenesulphonate (C₈-OBS), perhydrolyzable esters, 4-[N-(nonaoyl) amino hexanoyloxy]-benzene sulfonate sodium salt (NACA-OBS), lauryloxybenzenesulphonate (LOBS or C₁₂-OBS), 10-undecenoyloxybenzenesulfonate (UDOBS or C₁₁-OBS with unsaturation in the 10 position), and decanoyloxybenzoic acid (DOBA) and mixtures thereof, and further optionally comprises a bleach catalyst.
- 20
- 25

30

9. The bleaching composition according to Claim 1 wherein said bleaching agent

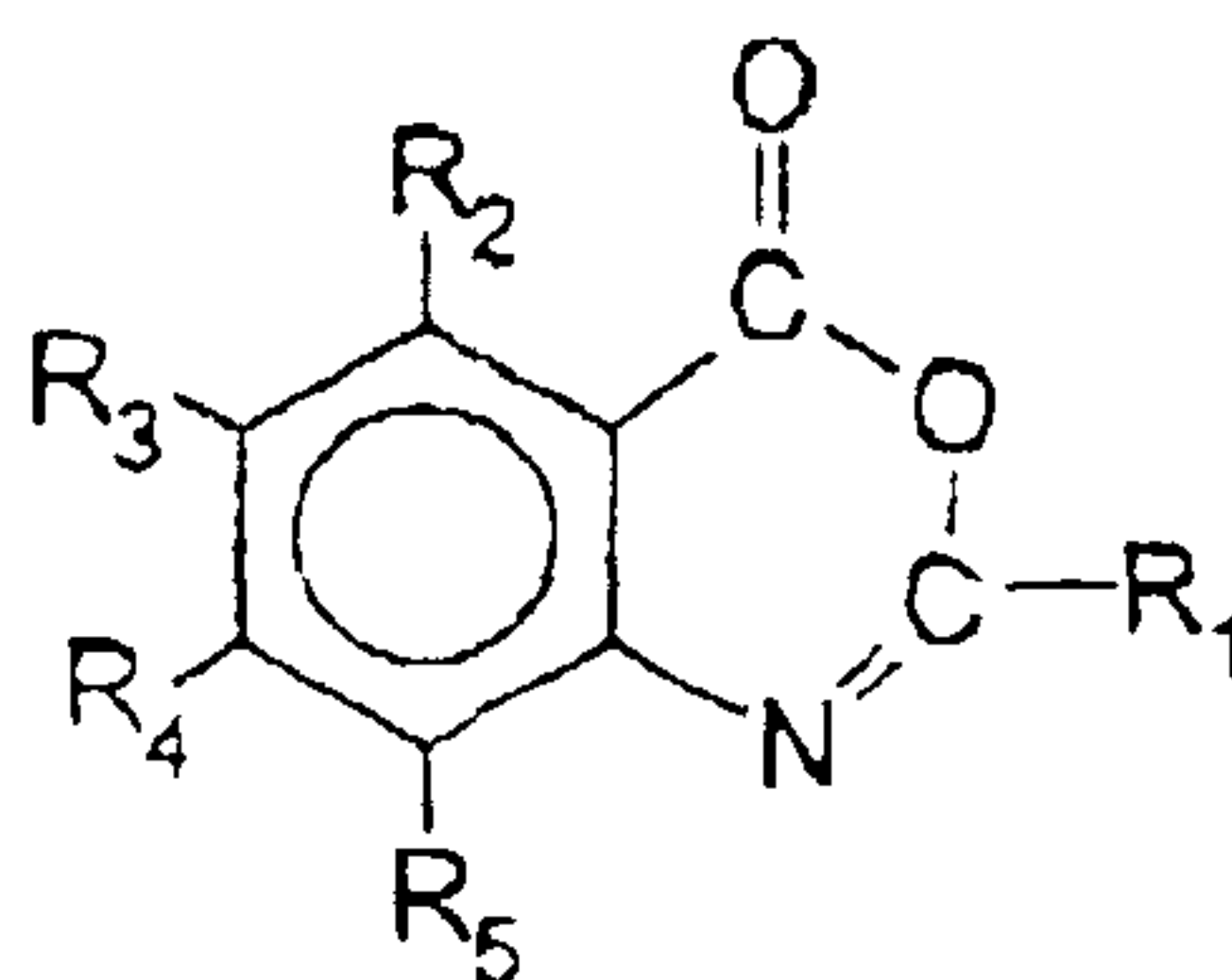
comprises at least 0.1% by weight of the bleaching agent of a peroxygen bleaching compound capable of yielding hydrogen peroxide in an aqueous liquor and at least 0.1% by weight of the bleaching agent of one or more bleach activators, wherein said bleach activators are members selected from the group consisting of:

- 5 a) a bleach activator of the general formula:



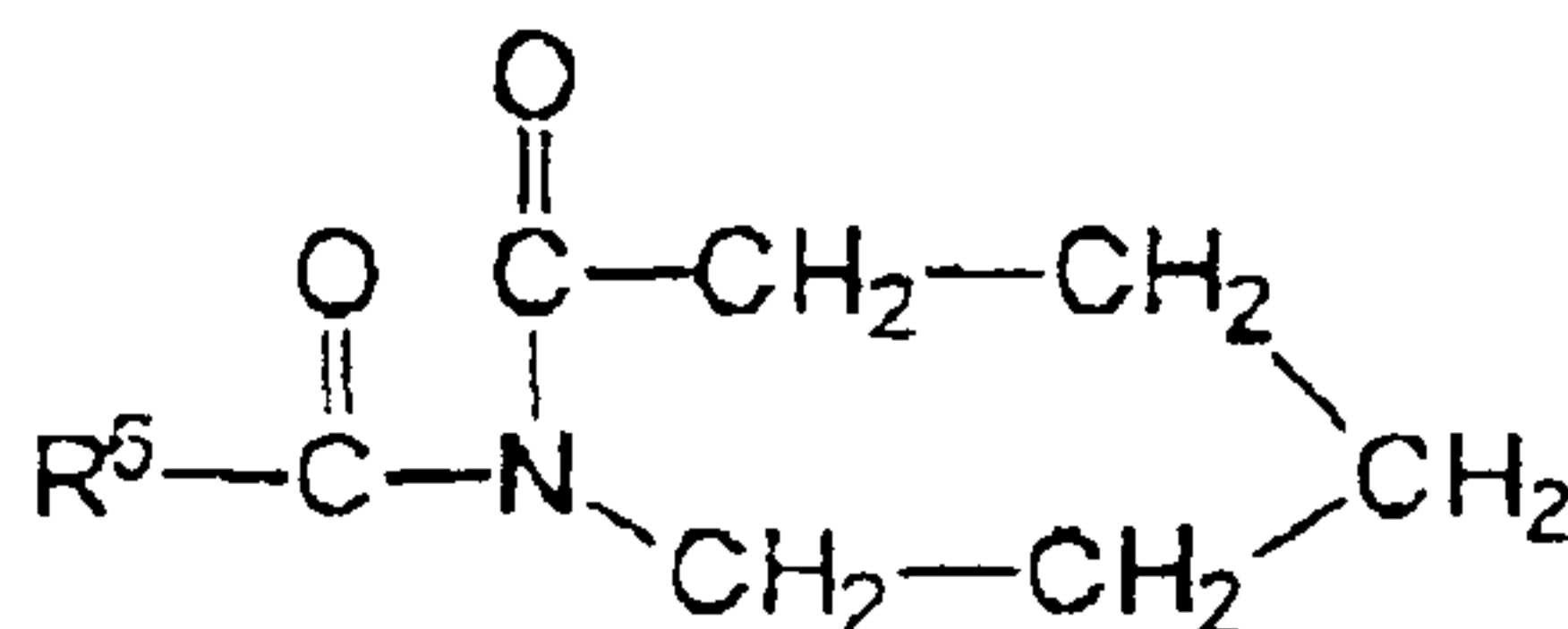
or mixtures thereof, wherein R^1 is an alkyl, aryl, or alkaryl group containing from 1 to 14 carbon atoms, R^2 is an alkylene, arylene or alkarylene group containing from 1 to 14 carbon atoms, R^5 is H or an alkyl, aryl, or alkaryl group containing from 1 to 10 carbon atoms,
10 and L is a leaving group;

- b) a benzoxazin-type bleach activator of the formula:



wherein R_1 is H, alkyl, alkaryl, aryl, arylalkyl, and wherein R_2 , R_3 , R_4 , and R_5 may be the same or different substituents selected from H, halogen, alkyl, alkenyl, aryl, hydroxyl,
15 alkoxy, amino, alkylamino, and $-\text{COOR}_6$, wherein R_6 is H or an alkyl group and carbonyl functions;

- c) a N-acyl caprolactam bleach activator of the formula:



wherein R^6 is H or an alkyl, aryl, alkoxyaryl, or alkaryl group containing from 1 to 12
20 carbons; and

- d) mixtures of a), b) and c).

10. The bleaching composition according to Claim 1 wherein the corresponding carboxylic acid of the organic peroxyacid bleaching agent has a Hydrophilic-Lipophilic
25 Balance value within the range of from 3 to 6.5.

11. The bleaching composition according to Claim 1 wherein said cleaning adjunct materials are selected from the group consisting of surfactants, solvents, buffers, enzymes, soil release agents, clay soil removal agents, dispersing agents, brighteners, suds suppressors, fabric softeners, suds boosters, enzyme stabilizers, builders, other bleaching agents, dyes, perfumes, chelants and mixtures thereof.

12. The bleaching composition according to Claim 11 wherein said cleaning adjunct materials comprise at least one deterative surfactant.

10

13. The bleaching composition according to Claim 11 wherein the cleaning adjunct materials comprise at least 0.1% surfactant by weight of the composition, said surfactant comprising materials selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl alkoxy carboxylates, alkyl polyglycosides, sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl alkoxylates, alkyl phenol alkoxylates, betaines, sulfobetaines, amine oxides, N-methyl glucamides, nonionic primary alcohol ethoxylates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof.

14. The bleaching composition according to Claim 13 further comprising at least 5% builder selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.

15. The bleaching composition according to Claim 11 wherein said cleaning adjunct materials comprise at least one deterative enzyme selected from the group consisting of cellulases, lipases, amylases, phospholipases, proteases other than those defined in Claim 1, peroxidases and mixtures thereof.

16. The bleaching composition according to Claim 1 wherein said bleaching composition is a fabric bleaching composition comprising at least about 5% surfactant and at least about 5% builder by weight of the composition.

17. The bleaching composition according to Claim 1 wherein said bleaching composition is a fabric bleaching composition comprising:

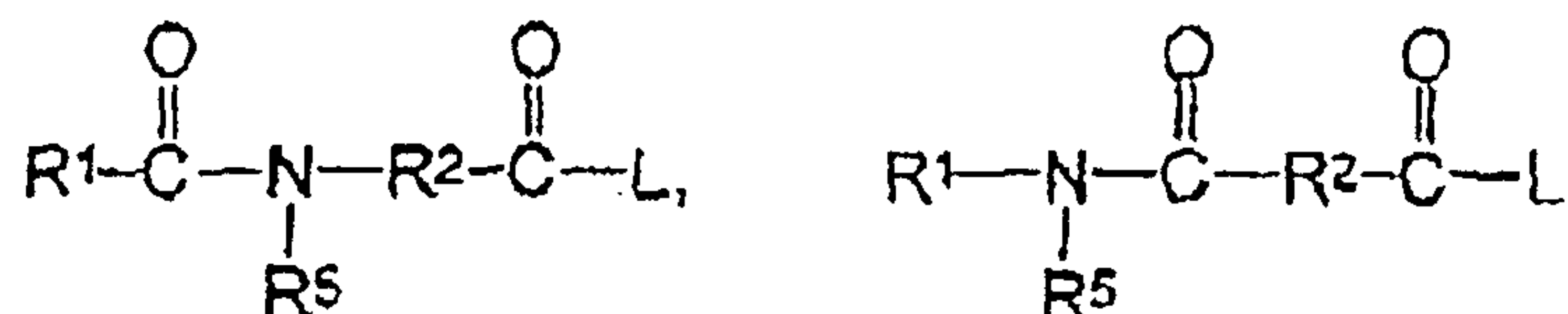
- (a) from 0.0001% to 10% by weight of said protease variant;
- (b) from 0.5% to 20% by weight of said bleaching agent;

- (c) at least 5% by weight of a surfactant; and
- (d) at least 5% by weight of a builder.

18. The bleaching composition according to Claim 17 is in the form of a concentrated
5 granular fabric bleaching composition comprising at least 15% surfactant.

19. The bleaching composition according to Claim 2 wherein the *Bacillus subtilisin* is
Bacillus lentus subtilisin or subtilisin 309.

10 20. The bleaching composition according to Claim 6 wherein said bleach activator has the
general formula:



or mixtures thereof, wherein R^1 is an alkyl, aryl, or alkaryl group containing from 1 to 14
carbon atoms, R^2 is an alkylene, arylene or alkarylene group containing from 1 to 14 carbon
15 atoms, R^5 is H or an alkyl, aryl, or alkaryl group containing from 1 to 10 carbon atoms, and L is
a leaving group.

21. The bleaching composition according to Claim 20 wherein R^1 is an alkyl group
containing from 6 to 12 carbon atoms, R^2 contains from 1 to 8 carbon atoms and R^5 is H or
20 methyl.

22. The bleaching composition according to Claim 8 wherein the bleach catalyst is 3-(3,4-
dihydroisoquinolinium) propane sulfonate.

25 23. The bleaching composition according to Claim 12 wherein the at least one deterative
surfactant is a branched surfactant.

24. The bleaching composition according to Claim 23 wherein the branched surfactant is a
mid-chain branched surfactant.

25. The bleaching composition according to Claim 16 wherein the fabric bleaching composition is in the form of a liquid, granule, tablet, powder or bar.

26. The bleaching composition according to Claim 17 wherein the surfactant is selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl alkoxy carboxylates, alkyl polyglycosides, sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl alkoxylates, alkyl phenol alkoxylates, betaines, sulfobetaines, amine oxides, N-methol glucamides, nonionic primary alcohol ethoxylates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof.

10

27. The bleaching composition according to Claim 17 wherein the builder is selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.

15 28. A method for cleaning fabric, said method comprising contacting a fabric in need of cleaning with a bleaching composition according to Claim 16 or 17.

29. The bleaching composition according to Claim 1 wherein said bleaching composition is a dishwashing bleaching composition comprising:

- 20 (a) from 0.0001% to 10% by weight of the dishwashing bleaching composition of said protease variant;
- (b) from 0.5% to 20% by weight of the dishwashing bleaching composition of said bleaching agent;
- (c) from 0.1% to 10% by weight of the dishwashing bleaching composition of a
- 25 surfactant.

30. The bleaching composition according to Claim 29 wherein the dishwashing bleaching composition is in the form of a liquid, granule, powder or tablet.

30 31. A method for cleaning dishes, said method comprising contacting a dish in need of cleaning with a bleaching composition according to Claim 29.

32. A personal cleansing composition comprising:

- (a) from 0.001% to 5% by weight of the personal cleansing composition of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 230 and 232 of *Bacillus amyloliquefaciens* subtilisin;
- (b) from 0.5% to 20% by weight of the personal cleansing composition of a bleaching agent which either is an organic peroxyacid or is a combination of a bleach activator and a peroxygen compound capable of yielding hydrogen peroxide that can react with the activator to form an organic peroxyacid in situ in a bleaching solution formed from the composition; and
- (c) from 0.1% to 95% by weight of the personal cleansing composition of a surfactant system; and
- (d) optionally, from 0.05% to 50% by weight of the personal cleansing composition of an enzyme stabilizer.

33. The personal cleansing composition according to Claim 32 wherein said surfactant is soap at a level of at least 2% by weight of the bleaching composition.

34. The personal cleansing composition according to Claim 33 wherein the ratio of soap to protease variant is from 2,000:1 to 8:1.

35. The personal cleansing composition according to Claim 32 wherein the protease variant is present in an amount of from 0.001% to 2% by weight of the personal cleansing composition.

36. The personal cleansing composition according to Claim 32 wherein the protease variant is present in an amount of from 0.01% to 0.8% by weight of the personal cleansing composition.

37. The personal cleansing composition according to Claim 32 wherein the surfactant system comprises one or more surfactants selected from the group consisting of anionic carboxylates, amine oxides, alkyl glucosides, glucose amides, alkyl sulfates, alkyl ether sulfates, acyl isethionates, alkyl sulfosuccinates, alkyl phosphate esters, ethoxylated phosphate esters, alkyl glyceryl ether sulfonates and mixtures thereof.

38. The personal cleansing composition according to Claim 32 wherein the surfactant system comprises one or more surfactants selected from the group consisting of soaps, acylglutamates, alkyl sarcosinates, lauramine oxides, cocamine oxides, cocamindopropylamine oxides, decylglucosides, lauryl sulfates, laureth sulfates, C₁₂₋₁₈ acyl isethionates and mixtures thereof.

39. The personal cleansing composition according to Claim 33 wherein the surfactant is soap at a level of at least 10% by weight of the bleaching composition.

40. The personal cleansing composition according to Claim 33 wherein the surfactant is soap at a level of at least 25% by weight of the bleaching composition.

41. The personal cleansing composition according to Claim 33 wherein the ratio of soap to protease variant is from 400:1 to 40:1.

42. A method for personal cleansing, said method comprising contacting a part of the human or lower animal body in need of cleaning with a personal cleansing composition according to Claim 32.

43. A method for pretreating a fabric in need of cleaning, said method comprising contacting said fabric prior to washing said fabric with an aqueous solution containing a surfactant with a bleaching composition according to Claim 16 or 17.

44. A bleaching composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232,

252 and 257 of *Bacillus amyloliquefaciens* subtilisin; wherein said protease variant includes substitutions of the amino acid residues at one or more of the following positions selected from the group consisting of:

- 1) position 62 and at one or more of the following positions 103, 104, 109, 159,
5 213, 232, 236, 245, 248 and 252;
- 2) position 212 and at one or more of the following positions 12, 98, 102, 103, 104,
159, 232, 236, 245, 248 and 252;
- 3) position 230 and at one or more of the following positions 68, 103, 104, 159,
232, 236 and 245;
- 10 4) position 232 and at one or more of the following positions: 12, 61, 62, 68, 76,
97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230,
236, 245, 248, 252, 257, 260, 270 and 275;
- 5) position 232 and at one or more of the following positions 103, 104, 236 and
245;
- 15 6) positions 232 and 103 and at one or more of the following positions: 12, 61, 62,
68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213,
217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 7) positions 232 and 104 and at one or more of the following positions: 12, 61, 62,
68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213,
20 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 8) positions 232 and 236 and at one or more of the following positions: 12, 61, 62,
68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213,
217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 9) positions 232 and 245 and at one or more of the following positions: 12, 61, 62,
25 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213,
217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 10) positions 232, 103, 104, 236 and 245 and at one or more of the following
positions: 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205,
209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 30 11) position 252 and at one or more of the following positions: 12, 61, 62, 68, 97,
98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245,
248 and 270;
- 12) position 252 and at one or more of the following positions 103, 104, 236 and
245;
- 35 13) positions 252 and 103 and at one or more of the following positions: 12, 61,
62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232,
236, 245, 248 and 270;

14) positions 252 and 104 and at one or more of the following positions: 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

5 15) positions 252 and 236 and at one or more of the following positions: 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

16) positions 252 and 245 and at one or more of the following positions: 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

10 17) positions 252, 103, 104, 236 and 245 and at one or more of the following positions: 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

18) position 257 and at one or more of the following positions 68, 103, 104, 205, 209, 210, 232, 236, 245 and 275.

15

45. A bleaching composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin; wherein said protease variant includes a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 61/68/103/104/159/232/236/245/248/252;
 62/103/104/130/159/213/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
 62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
 25 62/101/103/104/159/212/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252/270;
 68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
 68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
 68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
 30 68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
 68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
 68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
 68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
 35 68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
 68/76/103/104/159/213/232/236/245/260; 68/76/103/104/159/210/232/236/245/260;
 68/103/104/159/183/232/236/245/248/252; 68/103/104/232/236/245/257/275;

68/103/104/159/213/232/236/245; 76/103/104/159/232/236/245;
 76/103/104/159/213/232/236/245/260; 76/103/104/131/159/232/236/245/248/252;
 97/103/104/159/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
 98/102/103/104/159/212/232/236/245/248/252; 101/103/104/159/232/236/245/248/252;
 5 102/103/104/159/232/236/245/248/252; 103/104/159/232/236/245;
 103/104/159/248/252/270; 103/104/159/232/236/245/248/252;
 103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;
 103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
 103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
 10 103/104/131/159/232/236/245/248/252; 103/104/159/205/209/232/236/245; and
 103/104/159/232/236/245/257.

46. The bleaching composition according to Claim 45 wherein said protease variant includes a substitution set selected from the group consisting of:

15 12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/232V/236H/245R/248D/252K;
 20 62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
 62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
 68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/76D/103A/104I/159D/210L/232V/236H/245R/260A;
 68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
 25 68A/103A/104I/159D/209W/232V/236H/245R;
 68A/76D/103A/104I/159D/211R/232V/236H/245R;
 68A/76D/103A/104I/159D/215R/232V/236H/245R;
 68A/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/76D/103A/104I/159D/232V/236H/245R;
 30 68A/103A/104I/159D/232V/236H/245R/252K;
 68A/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/257V;
 68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
 35 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/230V/232V/236H/245R;

68A/76D/103A/104I/159D/209W/232V/236H/245R;
 68A/103A/104I/232V/236H/245R/248D/257V/275H;
 68A/103A/104I/232V/236H/245R/257V/275H;
 68A/103A/104I/213E/232V/236H/245R/248D/252K;
 5 68A/103A/104I/159D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210I/232V/236H/245R;
 68A/103A/104I/159D/210L/232V/236H/245R;
 68A/103A/104I/159D/213G/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
 10 76D/103A/104I/159D/232V/236H/245R;
 76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
 76D/103A/104I/159D/213R/232V/236H/245R/260A;
 97E/103A/104I/159D/232V/236H/245R/248D/252K;
 98L/103A/104I/159D/232V/236H/245R/248D/252K;
 15 98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K;
 20 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/159D/248D/252K/270V;
 103A/104I/159D/232V/236H/245R;
 103A/104I/159D/205I/209W/232V/236H/245R;
 25 103A/104I/159D/232V/236H/245R/257V;
 103A/104I/159D/205I/209W/232V/236H/245R/257V;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
 103A/104I/159D/232V/245R/248D/252K.

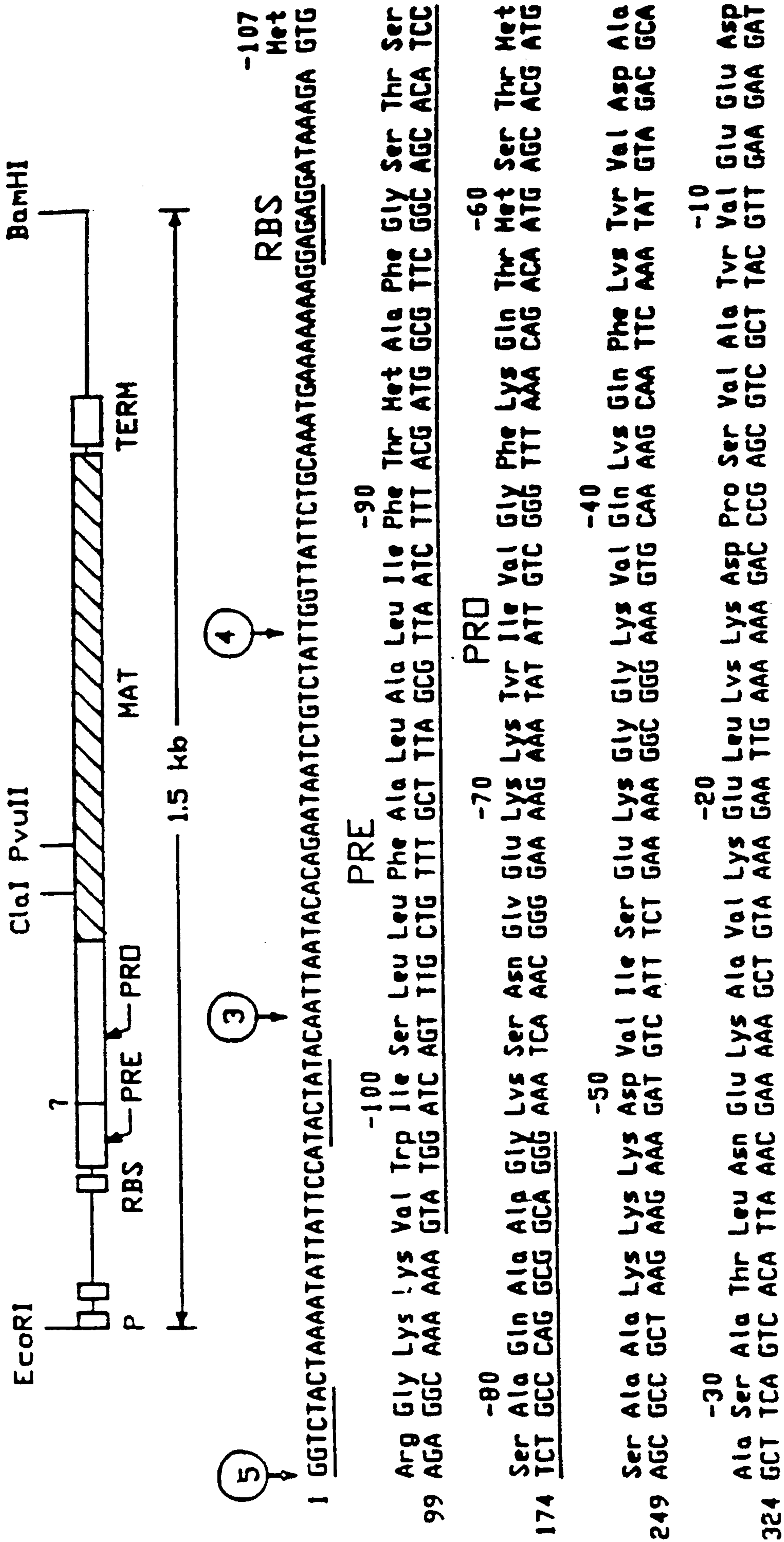


FIG.-1A

FIG-1B

3/6

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170      Lvs Tyr Pro Ser Val Ile Ala Val Glv Ala Val Asp Ser Ser Ser Asn Gln Arp Ala Ser Phe Ser Ser Vsl Glv Pro
924 AAA TAC CCT TCT GTC ATT GCA GTA GGC GCT GTT GAC AGC AGC AGC AAC CAA AGA GCA TCT TTC TCA AGC GTA GGA CCT

200      Glu Leu Asp Val Met Ala Pro Gly Val Ser Ile Gln Ser Thr Leu Pro Gly Asn Lvs Tyr Gly Ala Tyr Asn Glv
999 GAG CTT GAT GTC ATG GCA CCT GGC GTA TCT ATC CAA AGC ACG CTT CCT GGA AAC AAA TAC GGG GCG TAC AAC GGT

220      Thr Ser Met Ala Ser Pro His Val Ala Gly Aal Ala Ala Leu Ile Leu Ser Lvs His Pro Asn Trp Thr Asn Thr
1074 ACG TCA ATG GCA TCT CCG CAC GGT GCC GGA GCG GCT GCT TIG ATT CTT TCT TCT AAG CAC CCG AAC TGG ACA AAC ACT

250 Gln
Gln Val Aro Ser Ser Leu Glu Asn Thr Thr Lvs Leu Gly Asp Ser Phe Tyr Tyr Glv Lvs Glv Leu Ile Asn
1149 CAA GTC CCG AGC AGT TTA GAA AAC ACC ACT ACA AAA CTT GGT CAT TCT TIG TAC TAT GGA AAA GGG CTG ATC AAC

270      Val Gln Ala Ala Ala Gln DC
1224 GTA CAA GCG GCA GCT CAG TAA  AACATAAAACCGGCTTGGCCCGCGGTTTTTATTATTTTCTCCGCATGTTCAATCCGCTCC

1316 ATAATCGACGGATGGCTCCCTCTGAAATTTTAACGAGAAACGGGGTTGACCCGGCTCAGTCCCGTAACGGCCAACCTCTGAAACGTCATCGCCG

1416 CTTCCCGGTTTCCGGTCAGCTCAATGCCATAACGGTCGGCGGCGTTTCCTCGATACCGGGAGACGGCATTCGTAATCGGATC

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FIG.-1C

4/6

**CONSERVED RESIDUES IN SUBTILISINS FROM
BACILLUS AMYLOLIQUEFACIENS**

1	10	20
A Q S V P . G	A P A . H . . .	G
21	30	40
. T G S . V K V A V . D . G	H P	
41	50	60
D L . . . G G A S . V P	Q D	
61	70	80
. N . H G T H V A G T . A A L N N S I G		
81	90	100
V L G V A P S A . L Y A V K V L G A . G		
101	110	120
S G . . S . L . . G . E W A . N		
121	130	140
V . N . S L G . P S . S	A . .	
141	150	160
. G V . V V A A . G N . G . . .		
161	170	180
. Y P . . Y A V G A .		
181	190	200
D . . N . . A S F S . . G . . L D . . A		
201	210	220
P G V . . Q S T . P G . . Y . . . N G T		
221	230	240
S M A . P H V A G A A A L . . . K . . .		
241	250	260
W . . . Q . R . . L . N T . . . L G . .		
261	270	
. . Y G . G L . N . . A A . .		

FIG. 2

Comparison of subtilisin sequences from:

- B.amyloliquefaciens
- B.subtilis
- B.licheniformis
- B.lentus

01	A	Q	S	V	P	Y	G	V	S	Q	I	K	A	P	A	L	H	S	Q	G	Y	T	G	S	N	V	K	V	A	V	I	D	S	G	I	D	S	S	H	P	
	A	Q	S	V	P	Y	G	I	S	Q	I	K	A	P	A	L	H	S	Q	G	Y	T	G	S	N	V	K	V	A	V	I	D	S	G	I	D	S	S	H	P	
	A	Q	T	V	P	W	G	I	P	L	I	K	A	D	K	V	Q	A	Q	R	G	L	T	G	S	N	V	K	V	A	V	L	D	T	G	I	Q	S	T	H	P
	A	Q	S	V	P	W	G	I	S	R	V	Q	A	P	A	A	H	N	A	R	G	L	T	G	S	N	V	K	V	A	V	L	D	T	G	I	Q	S	T	H	P
41	D	L	K	V	A	G	G	A	S	M	V	P	S	E	T	N	P	F	Q	D	N	S	H	G	T	H	V	A	G	T	V	A	A	L	N	N	S	I	G		
	D	L	N	V	A	R	G	A	S	F	V	P	S	E	T	N	P	Y	Q	D	N	S	H	G	T	H	V	A	G	T	V	A	A	L	N	N	S	I	G		
	D	L	N	V	V	G	G	A	S	F	V	P	S	E	T	N	P	H	T	D	N	S	H	G	T	H	V	A	G	T	V	A	A	L	N	N	S	I	G		
	D	L	N	I	R	G	G	A	S	F	V	P	S	E	T	N	P	S	T	Q	D	N	S	H	G	T	H	V	A	G	T	V	A	A	L	N	N	S	I	G	
81	V	L	G	V	A	P	S	A	S	L	Y	A	V	K	V	L	G	A	D	G	S	Q	Y	S	W	I	I	I	H	G	I	E	W	A	I	A	N	N	M	D	
	V	L	G	V	A	P	S	A	S	L	Y	A	V	K	V	L	G	A	D	G	S	Q	Y	S	W	I	I	I	H	G	I	E	W	A	I	A	N	N	M	D	
	V	L	G	V	A	P	S	A	S	L	Y	A	V	K	V	L	G	A	D	G	S	Q	Y	S	W	I	I	I	H	G	I	E	W	A	I	A	N	N	M	D	
	V	L	G	V	A	P	S	A	S	L	Y	A	V	K	V	L	G	A	D	G	S	Q	Y	S	W	I	I	I	H	G	I	E	W	A	I	A	N	N	M	D	
121	V	I	N	M	S	L	G	G	P	S	G	S	A	A	L	K	A	V	D	K	A	V	A	S	G	V	V	V	V	A	A	A	A	G	N	E	G	T	S	G	
	V	I	N	M	S	L	G	G	P	T	G	S	A	A	L	K	A	V	D	K	A	V	A	S	G	V	V	V	V	A	A	A	A	G	N	E	G	T	S	G	
	V	I	N	M	S	L	G	G	A	S	G	S	A	A	L	K	A	V	D	K	A	V	A	S	G	V	V	V	V	A	A	A	A	G	N	E	G	T	S	G	
	V	A	N	L	S	L	G	S	P	S	P	S	A	A	L	K	A	V	D	N	S	A	T	S	R	G	V	V	V	V	A	A	A	A	G	N	E	G	T	S	G

FIG 3/A

FIG 3/B