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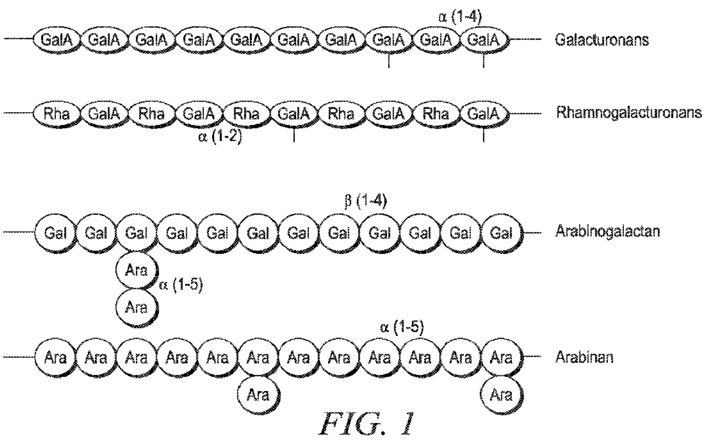


FIG. 1

(57) **Abstract**: Soy polysaccharide ether compounds are disclosed herein comprising uncharged, anionic, and/or cationic organic groups. The degree of substitution of one or more ether compounds is about 0.0025 to about 3.0. Also disclosed are methods of producing these soy polysaccharide ether compounds, as well as methods of their use for increasing the viscosity of aqueous compositions. Compositions comprising ether compounds are also disclosed.

TITLE

SOY POLYSACCHARIDE ETHERS

This application claims the benefit of U.S. Provisional Application Nos. 62/117,533 (filed February 18, 2015) and 62/117,537 (filed February 18, 2015), which are both incorporated herein by reference in their entirety.

FIELD OF INVENTION

The present disclosure is in the field of soy polysaccharide derivatives. Specifically, the disclosure pertains to soy polysaccharide ethers and methods of their preparation and use as viscosity modifiers.

BACKGROUND

Soy polysaccharide (soy fiber) is produced in large quantities as a byproduct of protein and oil isolation during soybean processing. This carbohydrate byproduct, which is commonly referred to as soy spent flakes or soy fiber, is composed primarily of water-insoluble cell wall polysaccharides. Although the polysaccharide components of this material obtained from some isolation processes can make up over 80% of its dry matter, limited knowledge exists of the exact structure and linkages of these carbohydrates. Structural analyses have indicated that soy polysaccharide is composed primarily of various monosaccharides including galactose, glucose, arabinose, galacturonic acid, xylose, rhamnose and fucose (Aspinall et al., *J. Chem. Soc. C*(0), 1065-1070). Also, it has been shown that soy polysaccharide contains spans of certain polysaccharide, such as galacturonans, rhamnogalacturonans, arabinogalactans and arabinans (FIG. 1).

Soy polysaccharide is generally insoluble in many types of solvents, including water. For this reason, recent studies on this type of polysaccharide have focused on either chemical extraction alone (Li et al., *Molecules* 17:753-761) or in combination with enzymatic hydrolysis (Yamaguchi et al., *Carbohydrate Polymers* 30:265-273) to solubilize the polysaccharide for structural analysis. These types of solubilization techniques have made soy polysaccharide more accessible to structural analysis techniques (e.g., NMR, SEC).

Despite these advances, development of new techniques for solubilizing soy polysaccharides could be beneficial. Solubilized soy polysaccharides produced by alternative means (e.g., derivatization) could have wide utility, such as in viscosity modification applications.

SUMMARY OF INVENTION

In one embodiment, the disclosure concerns a composition comprising a soy polysaccharide ether compound, wherein the compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.

In another embodiment, the degree of substitution with at least one organic group is less than 1.80.

In another embodiment, at least one organic group is an alkyl, hydroxy alkyl, or carboxy alkyl group. At least one organic group is a methyl, ethyl, hydroxypropyl, dihydroxypropyl, hydroxyethyl, or carboxymethyl group in another embodiment.

In another embodiment, at least one organic group is a positively charged organic group. At least one positively charged organic group in another embodiment comprises a substituted ammonium group. A substituted ammonium group is a trimethylammonium group in another embodiment. In another embodiment, at least one positively charged organic group is a quaternary ammonium hydroxypropyl group.

In another embodiment, the compound contains one type of organic group.

In another embodiment, the compound contains two or more types of organic groups.

In another embodiment, the composition is an aqueous composition having a viscosity of at least about 3 cPs. The aqueous composition is in the form of a personal care product, pharmaceutical product, food product, household product, or industrial product in another embodiment.

In another embodiment, the compound is crosslinked. In another embodiment, the composition comprising a crosslinked compound is an aqueous composition having a viscosity of at least about 50 cPs. Such an aqueous composition is in the form of a personal care product, pharmaceutical product, food product, household product, or industrial product in another embodiment.

In another embodiment, the disclosure concerns a method of producing a soy polysaccharide ether compound. This method comprises: (a) contacting soy polysaccharide in a reaction under alkaline conditions with at least one etherification agent comprising an organic group, wherein at least one organic group is etherified to the soy polysaccharide thereby producing a soy polysaccharide ether compound, wherein the compound has a degree of substitution with the organic group of about

0.0025 to about 3.0; and (b) optionally, isolating the soy polysaccharide ether compound produced in step (a).

In another embodiment, the disclosure concerns a method for increasing the viscosity of an aqueous composition. This method comprises: contacting a soy polysaccharide ether compound with the aqueous composition, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0, and wherein the viscosity of the aqueous composition is increased by the compound compared to the viscosity of the aqueous composition before the contacting step.

In another embodiment, the disclosure concerns a method of treating a material. This method comprises: contacting a material with an aqueous composition comprising a soy polysaccharide ether compound, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG: 1: Types of polysaccharides typically found within soy polysaccharide polymer. GalA, galacturonic acid; Rha, rhamnose; Gal, galactose; Ara, arabinose.

FIG. 2: Process for preparing insoluble soy polysaccharide. Refer to Examples.

DETAILED DESCRIPTION

The disclosures of all patent and non-patent literature cited herein are incorporated herein by reference in their entirety.

Unless otherwise disclosed, the terms “a” and “an” as used herein are intended to encompass one or more (i.e., at least one) of a referenced feature.

Where present, all ranges are inclusive and combinable, except as otherwise noted. For example, when a range of “1 to 5” is recited, the recited range should be construed as including ranges “1 to 4”, “1 to 3”, “1-2”, “1-2 & 4-5”, “1-3 & 5”, and the like.

The terms “soy polysaccharide” and “soy fiber” are used interchangeably herein, and refer to the high molecular weight, water-insoluble polysaccharide material of soybeans. Typically, soy polysaccharide is obtained from cell wall structural components of soybeans.

The terms “glycosidic linkage”, “glycosidic bond” and the like are used interchangeably herein and refer to the type of covalent bond that joins a carbohydrate molecule to another carbohydrate molecule. The glycosidic linkage profile of soy polysaccharide herein can be determined using any method known in the art. For example, a linkage profile can be determined using methods that use nuclear magnetic resonance (NMR) spectroscopy (e.g., ^{13}C NMR or ^{1}H NMR). These and other methods that can be used are disclosed in Food Carbohydrates: Chemistry, Physical Properties, and Applications (S. W. Cui, Ed., Chapter 3, S. W. Cui, Structural Analysis of Polysaccharides, Taylor & Francis Group LLC, Boca Raton, FL, 2005), which is incorporated herein by reference.

The "molecular weight" of soy polysaccharide or a soy polysaccharide ether compound herein can be represented as weight-average molecular weight (M_w) or number-average molecular weight (M_n), the units of which are in Daltons or grams/mole. Alternatively, molecular weight can be represented as DP_w (weight average degree of polymerization) or DP_n (number average degree of polymerization). Various means are known in the art for calculating these molecular weight measurements such as with high-pressure liquid chromatography (HPLC), size exclusion chromatography (SEC), or gel permeation chromatography (GPC).

The terms "soy polysaccharide ether compound", "soy polysaccharide ether", "soy polysaccharide ether derivative" and the like are used interchangeably herein. A soy polysaccharide ether compound herein is soy polysaccharide that has been etherified with one or more organic groups (uncharged, anionic, and/or cationic) such that the compound has a degree of substitution (DoS) with one or more organic groups of about 0.0025 to about 3.0. Such etherification typically occurs at one or more hydroxyl groups of at least 30% of the monosaccharide monomeric units of the soy polysaccharide.

A soy polysaccharide ether compound is termed an "ether" herein by virtue of comprising the substructure $-C_M-O-C-$, where "$-C_M-$" represents a carbon atom of a monosaccharide monomeric unit of a soy polysaccharide ether compound (where such carbon atom was bonded to a hydroxyl group [-OH] in the soy polysaccharide precursor of the ether), and where "-C-" is a carbon atom of an organic group. It would be understood that a monosaccharide monomeric unit of a soy polysaccharide ether compound herein typically has one or more organic groups in ether linkage. Thus, such a monosaccharide monomeric unit can also be referred to as an etherized monosaccharide monomeric unit.

An "organic group" group as used herein can refer to a chain of one or more carbons that (i) has the formula $-C_nH_{2n+1}$ (i.e., an alkyl group, which is completely saturated) or (ii) is mostly saturated but has one or more hydrogens substituted with another atom or functional group (i.e., a “substituted alkyl group”). Such substitution may be with one or more hydroxyl groups, oxygen atoms (thereby forming an aldehyde or ketone group), carboxyl groups, or other alkyl groups. Thus, as examples, an organic group herein can be an alkyl group, carboxy alkyl group, or hydroxy alkyl group. An organic group may thus be uncharged or anionic (an example of an anionic organic group is a carboxy alkyl group) in some embodiments.

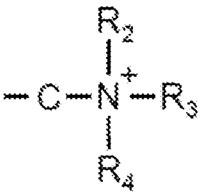
A “carboxy alkyl” group herein refers to a substituted alkyl group in which one or more hydrogen atoms of the alkyl group are substituted with a carboxyl group. A “hydroxy alkyl” group herein refers to a substituted alkyl group in which one or more hydrogen atoms of the alkyl group are substituted with a hydroxyl group.

An “organic group” can alternatively refer to a “positively charged organic group”. A positively charged organic group as used herein refers to a chain of one or more carbons (“carbon chain”) that has one or more hydrogens substituted with another atom or functional group (i.e., a “substituted alkyl group”), where one or more of the substitutions is with a positively charged group. Where a positively charged organic group has a substitution in addition to a substitution with a positively charged group, such additional substitution may be with one or more hydroxyl groups, oxygen atoms (thereby forming an aldehyde or ketone group), alkyl groups, and/or additional positively charged groups. A positively charged organic group has a net positive charge since it comprises one or more positively charged groups.

The terms “positively charged group”, “positively charged ionic group” and “cationic group” are used interchangeably herein. A positively charged group comprises a cation (a positively charged ion). Examples of positively charged groups include substituted ammonium groups, carbocation groups and acyl cation groups.

A composition that is “positively charged” or “cationic” herein typically has more protons than electrons and is repelled from other positively charged substances, but attracted to negatively charged substances. Soy polysaccharide ether compounds in some aspects can optionally be characterized as cationic soy polysaccharide ether compounds.

The terms “substituted ammonium group”, “substituted ammonium ion” and “substituted ammonium cation” are used interchangeably herein. A substituted ammonium group herein comprises structure I:


$$-C-\overset{\overset{R_2}{|}}{\underset{\underset{R_4}{|}}{N^{+}}}-R_3$$

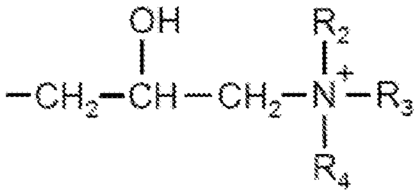
(I).

R_2, R_3 and R_4 in structure I each independently represent a hydrogen atom or an alkyl, aryl, cycloalkyl, aralkyl, or alkaryl group. The carbon atom (C) in structure I is part of the chain of one or more carbons (“carbon chain”) of the positively charged organic group. The carbon atom is either directly ether-linked to a monosaccharide monomeric unit of soy polysaccharide, or is part of a chain of two or more carbon atoms ether-linked to a monosaccharide monomeric unit of soy polysaccharide. The carbon atom in structure I can be $-CH_2-$, -CH- (where a H is substituted with another group such as a hydroxy group), or -C- (where both H’s are substituted).

A substituted ammonium group can be a “primary ammonium group”, “secondary ammonium group”, “tertiary ammonium group”, or “quaternary ammonium” group, depending on the composition of R_2, R_3 and R_4 in structure I. A primary ammonium group herein refers to structure I in which each of R_2, R_3 and R_4 is a hydrogen atom (i.e., $-C-NH_3^+$). A secondary ammonium group herein refers to structure I in which each of R_2 and R_3 is a hydrogen atom and R_4 is an alkyl, aryl, or cycloalkyl group. A tertiary ammonium group herein refers to structure I in which R_2 is a hydrogen atom and each of R_3 and R_4 is an alkyl, aryl, or cycloalkyl group. A quaternary ammonium group herein refers to structure I in which each of R_2, R_3 and R_4 is an alkyl, aryl, or cycloalkyl group (i.e., none of R_2, R_3 and R_4 is a hydrogen atom).

A quaternary ammonium soy polysaccharide ether herein can comprise a trialkyl ammonium group (where each of R_2, R_3 and R_4 is an alkyl group), for example. A trimethylammonium group is an example of a trialkyl ammonium group, where each of R_2, R_3 and R_4 is a methyl group. It would be understood that a fourth member (i.e., R_1) implied by “quaternary” in this nomenclature is the chain of one or more carbons of the positively charged organic group that is ether-linked to a monosaccharide monomeric unit of soy polysaccharide.

An example of a quaternary ammonium soy polysaccharide ether compound is trimethylammonium hydroxypropyl soy polysaccharide. The positively charged organic group of this ether compound can be represented as structure II:



$$-CH_2-\overset{OH}{\overset{|}{CH}}-CH_2-\overset{R_2}{\overset{|}{\underset{\underset{R_4}{|}}{N^+}}}-R_3$$

(II), where each of R_2, R_3 and R_4 is a methyl group. Structure II is an example of a quaternary ammonium hydroxypropyl group.

A “halide” herein refers to a compound comprising one or more halogen atoms (e.g., fluorine, chlorine, bromine, iodine). A halide herein can refer to a compound comprising one or more halide groups such as fluoride, chloride, bromide, or iodide. A halide group may serve as a reactive group of an etherification agent.

The terms “reaction”, “reaction composition”, “etherification reaction” and the like are used interchangeably herein and refer to a reaction comprising at least soy polysaccharide and an etherification agent. These components are typically mixed (e.g., resulting in a slurry) and/or dissolved in a solvent (organic and/or aqueous) comprising alkali hydroxide. A reaction is placed under suitable conditions (e.g., time, temperature) for the etherification agent to etherify one or more hydroxyl groups of monosaccharide monomeric units of soy polysaccharide with an organic group herein, thereby yielding a soy polysaccharide ether compound.

The term “alkaline conditions” herein refers to a solution or mixture pH of at least 11 or 12. Alkaline conditions can be prepared by any means known in the art, such as by dissolving an alkali hydroxide in a solution or mixture.

The terms “mercerization”, “mercerization process” and the like are used interchangeably herein to refer to a process in which soy polysaccharide material is treated under caustic alkali conditions, typically comprising sodium hydroxide. Mercerized soy polysaccharide is typically used in etherification reactions of the present disclosure.

The terms “etherification agent”, “alkylation agent” and the like are used interchangeably herein. An etherification agent herein refers to an agent that can be used to etherify one or more hydroxyl groups of one or more monosaccharide monomeric units of soy polysaccharide with an organic group. An etherification agent thus comprises at least one organic group.

The term “degree of substitution” (DoS) as used herein refers to the average number of hydroxyl groups substituted in each monomeric unit of a soy polysaccharide ether compound.

The term “molar substitution” (M.S.) as used herein refers to the moles of an organic group per monomeric unit of a soy polysaccharide ether compound. M.S. can alternatively refer to the average moles of etherification agent used to react with each monomeric unit in soy polysaccharide (M.S. can thus describe the degree of derivatization with an etherification agent). It is noted that the M.S. value for soy polysaccharide may have no upper limit in some cases. For example, when an organic group containing a hydroxyl group (e.g., hydroxyethyl or hydroxypropyl) has been etherified to soy polysaccharide, the hydroxyl group of the organic group may undergo further reaction, thereby coupling more of the organic group to the soy polysaccharide.

The term “crosslink” herein refers to a chemical bond, atom, or group of atoms that connects two adjacent atoms in one or more polymer molecules. It should be understood that, in a composition comprising crosslinked soy polysaccharide ether, crosslinks can be between at least two soy polysaccharide ether molecules (i.e., intermolecular crosslinks); there can also be intramolecular crosslinking. A “crosslinking agent” as used herein is an atom or compound that can create crosslinks.

An “aqueous composition” herein has a liquid component that comprises at least about 10 wt% water, for example. Examples of aqueous compositions include mixtures, solutions, dispersions (e.g., colloidal dispersions), suspensions and emulsions, for example. Aqueous compositions in certain embodiments comprise soy polysaccharide ether that is (i) dissolved in the aqueous composition (i.e., in solution, and typically has viscosity), or (ii) not dissolved in the aqueous composition (e.g., present as a colloidal dispersion).

As used herein, the term “colloidal dispersion” refers to a heterogeneous system having a dispersed phase and a dispersion medium, i.e., microscopically dispersed insoluble particles (e.g., some forms of soy polysaccharide ether herein) are suspended throughout another substance (e.g., an aqueous composition such as water or aqueous solution). An example of a colloidal dispersion herein is a hydrocolloid. All, or a portion of, the particles of a colloidal dispersion such as a hydrocolloid can comprise certain soy polysaccharide ether compounds of the present disclosure. The terms “dispersant” and “dispersion agent” are used interchangeably herein to refer to a material that promotes the formation and/or stabilization of a dispersion.

The terms “hydrocolloid” and “hydrogel” are used interchangeably herein. A hydrocolloid refers to a colloid system in which water or an aqueous solution is the dispersion medium.

The term “aqueous solution” herein refers to a solution in which the solvent comprises water. An aqueous solution can serve as a dispersant in certain aspects herein. Soy polysaccharide ethers in certain embodiments can be dissolved, dispersed, or mixed within an aqueous solution.

The term “viscosity” as used herein refers to the measure of the extent to which a fluid or an aqueous composition resists a force tending to cause it to flow. Various units of viscosity that can be used herein include centipoise (cPs) and Pascal-second (Pa·s). One poise is equal to 0.100 $kg \cdot m^{-1} \cdot s^{-1}$, or 1 mPa·s. Thus, the terms “viscosity modifier” and “viscosity-modifying agent” as used herein refer to anything that can alter/modify the viscosity of a fluid or aqueous composition.

The term “shear thinning behavior” as used herein refers to a decrease in the viscosity of an aqueous composition as shear rate increases. The term “shear thickening behavior” as used herein refers to an increase in the viscosity of an aqueous composition as shear rate increases. “Shear rate” herein refers to the rate at which a progressive shearing deformation is applied to an aqueous composition. A shearing deformation can be applied rotationally, for example.

The term “contacting” as used herein with respect to methods of increasing the viscosity of an aqueous composition refers to any action that results in bringing together an aqueous composition with at least one soy polysaccharide ether compound as presently disclosed. Contacting can be performed by any means known in the art, such as mixing, shaking, or homogenization, for example.

The terms “fabric”, “textile”, “cloth” and the like are used interchangeably herein to refer to a woven material having a network of natural and/or artificial fibers. Such fibers can be in the form of thread or yarn, for example.

A “fabric care composition” herein is any composition suitable for treating fabric in some manner. Examples of such a composition include laundry detergents and fabric softeners.

The terms “heavy duty detergent”, “all-purpose detergent” and the like are used interchangeably herein to refer to a detergent useful for regular washing of white and colored textiles at any temperature. The terms “low duty detergent”, “fine fabric detergent" and the like are used interchangeably herein to refer to a detergent useful for the care of delicate fabrics such as viscose, wool, silk, microfiber or other fabric requiring special care. "Special care" can include conditions of using excess water, low agitation, and/or no bleach, for example.

A "detergent composition" herein typically comprises at least one surfactant (detergent compound) and/or at least one builder. A "surfactant" herein refers to a substance that tends to reduce the surface tension of a liquid in which the substance is dissolved. A surfactant may act as a detergent, wetting agent, emulsifier, foaming agent, and/or dispersant, for example.

The terms "anti-redeposition agent", "anti-soil redeposition agent", "anti-greying agent" and the like herein refer to agents that help keep soils from redepositing onto clothing in laundry wash water after these soils have been removed, therefore preventing greying/discoloration of laundry. Anti-redeposition agents can function by helping keep soil dispersed in wash water and/or by blocking attachment of soil onto fabric surfaces.

An "oral care composition" herein is any composition suitable for treating any soft or hard surface in the oral cavity such as dental (teeth) and/or gum surfaces.

The term "adsorption" herein refers to the adhesion of a compound (e.g., soy polysaccharide ether herein) to the surface of a material.

The terms "percent by volume", "volume percent", "vol %", "v/v %" and the like are used interchangeably herein. The percent by volume of a solute in a solution can be determined using the formula: [(volume of solute)/(volume of solution)] x 100%.

The terms "percent by weight", "weight percentage (wt%)", "weight-weight percentage (% w/w)" and the like are used interchangeably herein. Percent by weight refers to the percentage of a material on a mass basis as it is comprised in a composition, mixture, or solution.

The term "increased" as used herein can refer to a quantity or activity that is at least about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 50%, 100%, or 200% more than the quantity or activity for which the increased quantity or activity is being compared. The terms "increased", "elevated", "enhanced", "greater than", "improved" and the like are used interchangeably herein.

The term “isolated” as used herein refers material (e.g., soy polysaccharide ether) that has been completely or partially purified. Soy polysaccharide ether compounds of the present disclosure are synthetic, man-made compounds. Such compounds are believed to not occur in nature, and/or exhibit properties not believed to naturally occur.

Development of new techniques for solubilizing soy polysaccharides could be beneficial. As now shown herein, solubilized soy polysaccharides can be produced by ether-derivatization. Such derivatized soy polysaccharide compounds are expected to have wide utility, such as in viscosity modification applications.

Embodiments disclosed herein concern a composition comprising a soy polysaccharide ether compound, wherein the compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0. Significantly, such compounds are typically soluble in aqueous compositions, and can be used to increase the viscosity thereof. Also, solubilization of soy polysaccharides as disclosed herein avoids enzymatic and/or chemical hydrolysis processes, which were previously used to drive solvation of soy polysaccharide, but which can overly degrade the polysaccharide polymer.

Soy polysaccharide used to prepare soy polysaccharide ether compounds as disclosed herein is typically obtained as a byproduct of soybean protein and/or oil processing. Thus, soy polysaccharide herein can be derived from soybeans. Soybeans in certain aspects can be from cultivated soybean (*Glycine max*) or wild soybean (*Glycine soja*). Suitable *G. max* cultivars/varieties include Ohio FG1, Ohio FG2, Beeson (e.g., Beeson 80), Vinton 81, Willomi, Wolverine, Hawkeye, and Kanrich, for example. Additional examples of soybean plants from which soybeans can be obtained and used herein are disclosed in U.S. Patent Nos. 7777102, 8835722, 8822776, 7951995, 7951995, 7951995, 6147193, and 5852226, which are all incorporated herein by reference. Soybeans herein can be from non-genetically modified or genetically modified plants in some aspects.

Processing steps to obtain soy polysaccharide suitable for producing ether compounds of the present disclosure can follow those depicted in FIG. 2, if desired. For example, a soy polysaccharide production process can first comprise a step of producing white flakes from whole soybeans. Soy white flake production typically comprises: i) dehulling whole soybeans, ii) flaking the dehulled soybeans, iii) extracting soybean oil from the flaked soybeans with a solvent (e.g., organic solvent such as hexane), and 4) desolventizing the defatted soybeans (preferably without high heating or toasting) to produce white flakes. White flakes can also optionally be ground to soy flour, if desired, prior to the next step (protein extraction). Various procedures useful herein for producing soy white flakes are disclosed in, for example, U.S. Patent Nos. 5097017 and 3897574, as well as in Serrato (*J. Am. Oil Chem. Soc.* 58:157-159) and Becker (*J. Am. Oil Chem.* Soc. 55:754-761), all of which are incorporated herein by reference.

Protein extraction can follow production of white flakes. The first step of protein extraction, which typically produces soy polysaccharide, comprises mixing white flakes with water and a base (to increase pH) to form a slurry. Protein solubility is increased in the slurry due to the increased pH. The slurry is then subjected to a process for separating the liquid (comprising protein and soluble sugar fractions) from the solids (comprising insoluble polysaccharide fraction), such as by decanting, centrifugation, and/or filtration. Solid material ("spent flake") obtained by this process can optionally be subjected to another round of alkaline slurry formation followed by liquid removal to further remove protein and other soluble components. Solid material resulting from one or more of the foregoing protein extractions comprises soy polysaccharide, and is suitable for producing ether compounds as disclosed herein. A soy polysaccharide preparation can optionally be washed (once or multiple times), dried, and/or powderized prior to its use for producing ether compounds. Dry soy polysaccharide can range from off-white (e.g., light brown, tan) to brown in color in certain aspects herein.

Soy polysaccharide herein is typically water-insoluble or exhibits only very little water-solubility, but is dispersible in water. Thus, soy polysaccharide herein is typically non-gelling, but can form a paste (but not a gel) when mixed with water. In general, 0%, or less than 5%, 4%, 3%, 2%, 1%, 0.5%, 0.25%, or 0.1% of soy polysaccharide carbohydrate components are soluble in water, for example.

While most material in a dry soy polysaccharide preparation is insoluble polysaccharide material, other components can optionally be present, such as protein, lipid, and ash. It is believed that this residual soy material, which in some circumstances is not completely removed during soy protein/oil acquisition processing, does not greatly inhibit etherification of insoluble soy polysaccharide material as presently disclosed. Thus, a soy polysaccharide preparation herein can comprise at least about 50, 55, 60, 65, 70, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, or 99 wt% insoluble polysaccharide, for example, as measured on a dry basis (e.g., less than 1 or 0.5 wt% water). With respect to the presence of residual soy components, a soy polysaccharide preparation in some embodiments can comprise (i) less than about 25, 20, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 wt% protein; (ii) less than about 5, 4, 3, 2, or 1 wt% ash (minerals); (iii) less than about 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 wt% lipid; and/or (iv) less than about 5, 4, 3, 2, 1, or 0.5 wt% low molecular weight, water-soluble sugars, as measured on a dry basis (e.g., less than 1 or 0.5 wt% water). Other residual soy components that can be comprised within a soy polysaccharide preparation herein include isoflavones, lignans, phytosterols, coumestans, saponins and/or phytates, for example. In some embodiments, a soy polysaccharide preparation comprises about 84-86 wt% insoluble polysaccharide, 9-11 wt% protein, 3-4 wt% ash, and 0.5-1 wt% lipid.

Polysaccharide component(s) of a soy polysaccharide preparation suitable for ether production herein can comprise regions of one or more different types of polysaccharide chains, such as galacturonan, rhamnogalacturonan, arabinogalactan and/or arabinan (FIG. 1). Other polysaccharide sub-regions of soy polysaccharide may comprise galactan, xylogalacturonan, xylan, xyloglucan and/or cellulose, for example. Soy polysaccharide herein can comprise arabinose (Ara), galactose (Gal), xylose (Xyl), and galacturonic acid (GalA) as a majority of constituent monosaccharide monomeric units, as well as smaller amounts of rhamnose (Rha), glucose (Glc), fucose (Fuc) and mannose (Man). In certain embodiments, soy polysaccharide can comprise by weight ~21-28% Ara, ~14-42% Gal, ~10-35% GalA, ~5-17% Xyl, ~2-6% Rha, ~1-4% Fuc, ~1-4% Man, and/or ~1-6% Glc. Soy polysaccharide in certain other embodiments can comprise by weight ~11-13% Ara, ~40-42% Gal, ~30-32% Glc and Man, and ~2.5-3.5% Xyl. Soy polysaccharide can comprise polysaccharide sub-regions, monosaccharide monomers, and glycosidic linkage profiles disclosed in Li et al. (*Molecules* 17:753-761), for example, which is incorporated herein by reference.

Any soy polysaccharide ether compound disclosed herein can comprise one or more of the foregoing features regarding polysaccharide sub-regions, monosaccharide monomer composition, and/or glycosidic linkage profile, for example. Soy polysaccharide ether compounds in some embodiments can be derived from any soy polysaccharide as disclosed herein. For example, a soy polysaccharide ether compound can be produced by ether-derivatizing soy polysaccharide using an etherification reaction as disclosed herein. Certain embodiments herein encompass compositions comprising a soy polysaccharide ether compound and one or more of soy protein, soy lipid, and/or soy ash. It is contemplated that a soy polysaccharide ether preparation can comprise (on a dry weight basis) about 5, 6, 7, or 8 wt% protein, for example. In other examples, it is contemplated that a soy polysaccharide ether preparation can further comprise (on a dry weight basis) about 0.2, 0.3, 0.4, 0.5, or 0.6 wt% lipid, and/or about 0.5, 0.75, 1.0, 1.25 or 1.5 wt% minerals (ash). In some embodiments, it is contemplated that a soy polysaccharide ether can comprise different polysaccharide components, such as arabinan, arabinogalactan, homogalactan, homogalacturonan, rhamnogalacturonan, xyloglucan, and/or cellulose. As another example, it is contemplated that a soy polysaccharide ether can comprise arabinan, type I arabinogalactan, homogalactan, homogalacturonan, and/or rhamnogalacturonan.

The degree of substitution (DoS) of a soy polysaccharide ether compound with an organic group as disclosed herein can be about 0.0025 to about 3.0. Alternatively, the DoS can be about, or at least about, 0.0025, 0.005, 0.01, 0.025, 0.05, 0.075, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, or 3.0. The DoS in some aspects herein can be less than about 1.80. For example, DoS can range from about 0.0025 (or 0.005, 0.01, 0.025, 0.05, 0.075, or 0.1) to about 1.8 (or 1.7, 1.6, 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, or 0.2). Still in some aspects, such as in ethers with cationic groups, the DoS can be between about .65-2.5, .675-2.5, .690-2.5, .65-2.25, .675-2.25, .690-2.25, .65-2.15, .675-2.15, or .690-2.15 (e.g., .698-2.12). The DoS in some embodiments is associated with soy polysaccharide ether compounds that are soluble in aqueous compositions such as water and aqueous solutions.

The percentage of the monosaccharide units of a soy polysaccharide ether compound herein that are ether-linked to an organic group (i.e., where one or more hydroxyl groups of a monosaccharide monomeric unit have been etherified with an organic group) can vary depending on the degree to which a soy polysaccharide is etherified with an organic group in an etherification reaction. This percentage can be at least about 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% (or any integer value between 30% and 100%), for example.

The M_w or M_n of soy polysaccharide ether compounds herein can be about, or at least about, 50000, for example. Alternatively, the M_w or M_n can be about 50000 to about 1200000. Alternatively still, the M_w or M_n can be about, or at least about, 50000, 100000, 200000, 300000, 400000, 500000, 600000, 700000, 800000, 900000, 1000000, 1100000, 1200000 (or any integer between 50000 and 1200000), for example. In certain embodiments, the M_w or M_n can be about 600000-1000000, 600000-950000, 600000-900000, 650000-1000000, 650000-950000, 650000-900000, 700000-1000000, 700000-950000, or 700000-900000.

An organic group herein can be an alkyl group such as a methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, or decyl group, for example.

Alternatively, an organic group may be a substituted alkyl group in which there is a substitution on one or more carbons of the alkyl group. The substitution(s) may be one or more hydroxyl, aldehyde, ketone, and/or carboxyl groups. For example, a substituted alkyl group may be a hydroxy alkyl group, dihydroxy alkyl group, or carboxy alkyl group.

Examples of suitable hydroxy alkyl groups are hydroxymethyl ($-CH_2OH$), hydroxyethyl (e.g., $-CH_2CH_2OH$, $-CH(OH)CH_3$), hydroxypropyl (e.g., $-CH_2CH_2CH_2OH$, $-CH_2CH(OH)CH_3$, $-CH(OH)CH_2CH_3$), hydroxybutyl and hydroxypentyl groups. Other examples include dihydroxy alkyl groups (diols) such as dihydroxymethyl, dihydroxyethyl (e.g., $-CH(OH)CH_2OH$), dihydroxypropyl (e.g., $-CH_2CH(OH)CH_2OH$, $-CH(OH)CH(OH)CH_3$), dihydroxybutyl and dihydroxypentyl groups.

Examples of suitable carboxy alkyl groups are carboxymethyl ($-CH_2COOH$), carboxyethyl (e.g., $-CH_2CH_2COOH$, $-CH(COOH)CH_3$), carboxypropyl (e.g., $-CH_2CH_2CH_2COOH$, $-CH_2CH(COOH)CH_3$, $-CH(COOH)CH_2CH_3$), carboxybutyl and carboxypentyl groups.

Alternatively still, one or more carbons of an alkyl group can have a substitution(s) with another alkyl group. Examples of such substituent alkyl groups are methyl, ethyl and propyl groups. To illustrate, an organic group can be $-CH(CH_3)CH_2CH_3$ or $-CH_2CH(CH_3)CH_3$, for example, which are both propyl groups having a methyl substitution.

As should be clear from the above examples of various substituted alkyl groups, a substitution (e.g., hydroxy or carboxy group) on an alkyl group in certain embodiments may be bonded to the terminal carbon atom of the alkyl group, where the terminal carbon group is opposite the terminus that is in ether linkage to a monomeric unit (monosaccharide unit) in a soy polysaccharide ether compound. An example of this terminal substitution is the hydroxypropyl group $-CH_2CH_2CH_2OH$. Alternatively, a substitution may be on an internal carbon atom of an alkyl group. An example of an internal substitution is the hydroxypropyl group $-CH_2CH(OH)CH_3$. An alkyl group can have one or more substitutions, which may be the same (e.g., two hydroxyl groups [dihydroxy]) or different (e.g., a hydroxyl group and a carboxyl group).

Soy polysaccharide ether compounds in certain embodiments disclosed herein may contain one type of organic group. Examples of such compounds contain an alkyl group as the organic group (alkyl soy polysaccharide, generically speaking). A specific non-limiting example of such a compound is methyl soy polysaccharide. Other examples include soy polysaccharide ether compounds containing a dihydroxyalkyl as the organic group (dihydroxyalkyl soy polysaccharide, generically speaking). A specific non-limiting example of such a compound is dihydroxypropyl soy polysaccharide.

Alternatively, soy polysaccharide ether compounds disclosed herein can contain two or more different types of organic groups. Examples of such compounds contain (i) two different alkyl groups as organic groups, (ii) an alkyl group and a hydroxy alkyl group as organic groups (alkyl hydroxyalkyl soy polysaccharide, generically speaking), (iii) an alkyl group and a carboxy alkyl group as organic groups (alkyl carboxyalkyl soy polysaccharide, generically speaking), (iv) a hydroxy alkyl group and a carboxy alkyl group as organic groups (hydroxyalkyl carboxyalkyl soy polysaccharide, generically speaking), (v) two different hydroxy alkyl groups as organic groups, or (vi) two different carboxy alkyl groups as organic groups. Specific non-limiting examples of such compounds include ethyl hydroxyethyl soy polysaccharide, hydroxyalkyl methyl soy polysaccharide, carboxymethyl hydroxyethyl soy polysaccharide, and carboxymethyl hydroxypropyl soy polysaccharide.

Soy polysaccharide ether compounds herein can comprise at least one nonionic organic group and at least one anionic group, for example. As another example, soy polysaccharide ether compounds herein can comprise at least one nonionic organic group and at least one positively charged organic group. A soy polysaccharide ether compound in some aspects does not comprise a carboxymethyl group as an organic group, or as the only type of organic group.

An organic group herein can alternatively be a positively charged organic group in some aspects. A positively charged group herein can be a substituted ammonium group, for example. Examples of substituted ammonium groups are primary, secondary, tertiary and quaternary ammonium groups. Structure I depicts a primary, secondary, tertiary or quaternary ammonium group, depending on the composition of R_2, R_3 and R_4 in structure I. Each of R_2, R_3 and R_4 in structure I independently represents a hydrogen atom or an alkyl, aryl, cycloalkyl, aralkyl, or alkaryl group. Alternatively, each of R_2, R_3 and R_4 can independently represent a hydrogen atom or an alkyl group. An alkyl group can be a methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, or decyl group, for example. Where two or three of R_2, R_3 and R_4 are an alkyl group, they can be the same or different alkyl groups.

A “primary ammonium soy polysaccharide ether compound” herein can comprise a positively charged organic group having an ammonium group. In this example, the positively charged organic group comprises structure I in which each of R_2, R_3 and R_4 is a hydrogen atom. A non-limiting example of such a positively charged organic group is represented by structure II when each of R_2, R_3 and R_4 is a hydrogen atom. An example of a primary ammonium soy polysaccharide ether compound can be represented in shorthand as ammonium soy polysaccharide ether. It would be understood that a first member (i.e., R_1) implied by “primary” in the above nomenclature is the chain of one or more carbons of the positively charged organic group that is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound.

A “secondary ammonium soy polysaccharide ether compound” herein can comprise a positively charged organic group having a monoalkylammonium group, for example. In this example, the positively charged organic group comprises structure I in which each of R_2 and R_3 is a hydrogen atom and R_4 is an alkyl group. A non-limiting example of such a positively charged organic group is represented by structure II when each of R_2 and R_3 is a hydrogen atom and R_4 is an alkyl group. An example of a secondary ammonium soy polysaccharide ether compound can be represented in shorthand herein as monoalkylammonium soy polysaccharide ether (e.g., monomethyl-, monoethyl-, monopropyl-, monobutyl-, monopentyl-, monohexyl-, monoheptyl-, monooctyl-, monononyl-, or monodecyl-ammonium soy polysaccharide ether). It would be understood that a second member (i.e., R_1) implied by “secondary” in the above nomenclature is the chain of one or more carbons of the positively charged organic group that is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound.

A “tertiary ammonium soy polysaccharide ether compound” herein can comprise a positively charged organic group having a dialkylammonium group, for example. In this example, the positively charged organic group comprises structure I in which R_2 is a hydrogen atom and each of R_3 and R_4 is an alkyl group. A non-limiting example of such a positively charged organic group is represented by structure II when R_2 is a hydrogen atom and each of R_3 and R_4 is an alkyl group. An example of a tertiary ammonium soy polysaccharide ether compound can be represented in shorthand as dialkylammonium soy polysaccharide ether (e.g., dimethyl-, diethyl-, dipropyl-, dibutyl-, dipentyl-, dihexyl-, diheptyl-, dioctyl-, dinonyl-, or didecyl-ammonium soy polysaccharide ether). It would be understood that a third member (i.e., R_1) implied by “tertiary” in the above nomenclature is the chain of one or more carbons of the positively charged organic group that is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound.

A “quaternary ammonium soy polysaccharide ether compound” herein can comprise a positively charged organic group having a trialkylammonium group, for example. In this example, the positively charged organic group comprises structure I in which each of R_2, R_3 and R_4 is an alkyl group. A non-limiting example of such a positively charged organic group is represented by structure II when each of R_2, R_3 and R_4 is an alkyl group. An example of a quaternary ammonium soy polysaccharide ether compound can be represented in shorthand as trialkylammonium soy polysaccharide (e.g., trimethyl-, triethyl-, tripropyl-, tributyl-, tripentyl-, trihexyl-, triheptyl-, trioctyl-, trinonyl-, or tridecyl-ammonium soy polysaccharide ether).

Additional non-limiting examples of substituted ammonium groups that can serve as a positively charged group herein are represented in structure I when each of R_2, R_3 and R_4 independently represent a hydrogen atom; an alkyl group such as a methyl, ethyl, or propyl group; an aryl group such as a phenyl or naphthyl group; an aralkyl group such as a benzyl group; an alkaryl group; or a cycloalkyl group. Each of R_2, R_3 and R_4 may further comprise an amino group or a hydroxyl group, for example.

The nitrogen atom in a substituted ammonium group represented by structure I is bonded to a chain of one or more carbons as comprised in a positively charged organic group. This chain of one or more carbons ("carbon chain") is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound, and may have one or more substitutions in addition to the substitution with the nitrogen atom of the substituted ammonium group. There can be 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10 carbons, for example, in a carbon chain. To illustrate, the carbon chain of structure II is 3 carbon atoms in length.

Examples of a carbon chain of a positively charged organic group that do not have a substitution in addition to the substitution with a positively charged group include $-CH_2-$, $-CH_2CH_2-$, $-CH_2CH_2CH_2-$, $-CH_2CH_2CH_2CH_2-$ and $-CH_2CH_2CH_2CH_2CH_2-$. In each of these examples, the first carbon atom of the chain is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound, and the last carbon atom of the chain is linked to a positively charged group. Where the positively charged group is a substituted ammonium group, the last carbon atom of the chain in each of these examples is represented by the C in structure I.

Where a carbon chain of a positively charged organic group has a substitution in addition to a substitution with a positively charged group, such additional substitution may be with one or more hydroxyl groups, oxygen atoms (thereby forming an aldehyde or ketone group), alkyl groups (e.g., methyl, ethyl, propyl, butyl), and/or additional positively charged groups. A positively charged group is typically bonded to the terminal carbon atom of the carbon chain.

Examples of a carbon chain of a positively charged organic group having one or more substitutions with a hydroxyl group include hydroxyalkyl (e.g., hydroxyethyl, hydroxypropyl, hydroxybutyl, hydroxypentyl) groups and dihydroxyalkyl (e.g., dihydroxyethyl, dihydroxypropyl, dihydroxybutyl, dihydroxypentyl) groups. Examples of hydroxyalkyl and dihydroxyalkyl (diol) carbon chains include $-CH(OH)-$, $-CH(OH)CH_2-$, $-C(OH)_2CH_2-$, $-CH_2CH(OH)CH_2-$, $-CH(OH)CH_2CH_2-$, $-CH(OH)CH(OH)CH_2-$, $-CH_2CH_2CH(OH)CH_2-$, $-CH_2CH(OH)CH_2CH_2-$, $-CH(OH)CH_2CH_2CH_2-$, $-CH_2CH(OH)CH(OH)CH_2-$, $-CH(OH)CH(OH)CH_2CH_2-$ and $-CH(OH)CH_2CH(OH)CH_2-$. In each of these examples, the first carbon atom of the chain is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound, and the last carbon atom of the chain is linked to a positively charged group. Where the positively charged group is a substituted ammonium group, the last carbon atom of the chain in each of these examples is represented by the C in structure I.

Examples of a carbon chain of a positively charged organic group having one or more substitutions with an alkyl group include chains with one or more substituent methyl, ethyl and/or propyl groups. Examples of methylalkyl groups include $-CH(CH_3)CH_2CH_2-$ and $-CH_2CH(CH_3)CH_2-$, which are both propyl groups having a methyl substitution. In each of these examples, the first carbon atom of the chain is ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound, and the last carbon atom of the chain is linked to a positively charged group. Where the positively charged group is a substituted ammonium group, the last carbon atom of the chain in each of these examples is represented by the C in structure I.

Soy polysaccharide ether compounds in certain embodiments disclosed herein can contain one type of positively charged organic group. For example, one or more positively charged organic groups ether-linked to a monosaccharide unit of the soy polysaccharide component of the ether compound can be trimethylammonium hydroxypropyl groups (structure II). Alternatively, soy polysaccharide ether compounds disclosed herein can contain two or more different types of positively charged organic groups.

Soy polysaccharide ether compounds herein can further comprise at least one nonionic organic group and/or at least one anionic group, for example. As another example, soy polysaccharide ether compounds herein can comprise at least one nonionic organic group and at least one positively charged organic group.

In certain embodiments, a composition comprising a soy polysaccharide ether compound can be an aqueous composition having a viscosity of about, or at least about, 3 cPs. Alternatively, such an aqueous composition can have a viscosity of about, or at least about, 4, 5, 10, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 500, 750, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000, 15000, or 20000 cPs (or any integer between 3 and 20000 cPs), for example. Examples of aqueous compositions herein include hydrocolloids and aqueous solutions.

Viscosity can be measured with an aqueous composition herein at any temperature between about 3 °C to about 110 °C (or any integer between 3 and 110 °C). Alternatively, viscosity can be measured at a temperature between about 4 °C to 30 °C, or about 20 °C to 25 °C, for example. Viscosity can be measured at atmospheric pressure (about 760 torr) or any other higher or lower pressure.

The viscosity of an aqueous composition herein can be measured using a viscometer or rheometer, or using any other means known in the art. It would be understood by those skilled in the art that a viscometer or rheometer can be used to measure the viscosity of aqueous compositions that exhibit shear thinning behavior (i.e., having viscosities that vary with flow conditions). The viscosity in such embodiments can be measured at a rotational shear rate of about 0.1 to 1000 rpm (revolutions per minute), for example. Alternatively, viscosity can be measured at a rotational shear rate of about 10, 60, 150, 250, or 600 rpm.

The pH of an aqueous composition herein can be between about 2.0 to about 12.0, for example. Alternatively, pH can be about 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0; or between 5.0 to about 12.0; or between about 4.0 and 8.0; or between about 5.0 and 8.0, for example.

An aqueous composition herein such as a hydrocolloid or aqueous solution can comprise a solvent having at least about 10 wt% water. In other embodiments, a solvent is at least about 20, 30, 40, 50, 60, 70, 80, 90, or 100 wt% water (or any integer value between 10 and 100 wt%), for example.

A soy polysaccharide ether compound herein can be present in an aqueous composition at a wt% of about, or at least about, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, or 90 wt%, for example.

An aqueous composition herein can comprise other components in addition to a soy polysaccharide ether compound. For example, an aqueous composition can comprise one or more salts such as a sodium salt (e.g., NaCl, Na_2SO_4). Other non-limiting examples of salts include those having (i) an aluminum, ammonium, barium, calcium, chromium (II or III), copper (I or II), iron (II or III), hydrogen, lead (II), lithium, magnesium, manganese (II or III), mercury (I or II), potassium, silver, sodium strontium, tin (II or IV), or zinc cation, and (ii) an acetate, borate, bromate, bromide, carbonate, chlorate, chloride, chlorite, chromate, cyanamide, cyanide, dichromate, dihydrogen phosphate, ferricyanide, ferrocyanide, fluoride, hydrogen carbonate, hydrogen phosphate, hydrogen sulfate, hydrogen sulfide, hydrogen sulfite, hydride, hydroxide, hypochlorite, iodate, iodide, nitrate, nitride, nitrite, oxalate, oxide, perchlorate, permanganate, peroxide, phosphate, phosphide, phosphite, silicate, stannate, stannite, sulfate, sulfide, sulfite, tartrate, or thiocyanate anion. Thus, any salt having a cation from (i) above and an anion from (ii) above can be in an aqueous composition, for example. A salt can be present in an aqueous composition herein at a wt% of about .01 to about 10.00 (or any hundredth increment between .01 and 10.00), for example.

Those skilled in the art would understand that, in certain embodiments of the disclosure, a soy polysaccharide ether compound can be in an anionic form in an aqueous composition. Examples may include those soy polysaccharide ether compounds having an organic group comprising an alkyl group substituted with a carboxyl group. Carboxyl (COOH) groups in a carboxyalkyl soy polysaccharide ether compound can convert to carboxylate (COO^-) groups in aqueous conditions. Such anionic groups can interact with salt cations such as any of those listed above in (i) (e.g., potassium, sodium, or lithium cation). Thus, a soy polysaccharide ether compound can be a sodium carboxyalkyl soy polysaccharide ether (e.g., sodium carboxymethyl soy polysaccharide), potassium carboxyalkyl soy polysaccharide ether (e.g., potassium carboxymethyl soy polysaccharide), or lithium carboxyalkyl soy polysaccharide ether (e.g., lithium carboxymethyl soy polysaccharide), for example.

A soy polysaccharide ether compound in certain aspects is in a cationic form when comprised within an aqueous composition. The cationic groups of such a soy polysaccharide ether compound herein can interact with salt anions that may be present in an aqueous composition. Such salt anions can be any of those listed above in (ii) (e.g., chloride anion), for example.

A composition comprising a soy polysaccharide ether compound herein can be non-aqueous (e.g., a dry composition). Examples of such embodiments include powders, granules, microcapsules, flakes, or any other form of particulate matter. Other examples include larger compositions such as pellets, bars, kernels, beads, tablets, sticks, or other agglomerates. A non-aqueous or dry composition herein typically has less than 3, 2, 1, 0.5, or 0.1 wt% water comprised therein. The amount of soy polysaccharide ether compound herein in a non-aqueous or dry composition can be about, or at least about, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.5, or 99.9 wt%, for example.

A soy polysaccharide ether compound comprised in certain embodiments as presently disclosed may be crosslinked. Any means known in the art may be used to crosslink one or more soy polysaccharide ether compounds. Such crosslinks may be borate crosslinks, where the borate is from any boron-containing compound (e.g., boric acid, diborates, tetraborates [e.g., tetraborate decahydrate], pentaborates, polymeric compounds such as Polybor®, polymeric compounds of boric acid, alkali borates), for example. Alternatively, crosslinks can be provided with polyvalent metals such as titanium or zirconium. Titanium crosslinks may be provided, for example, using titanium IV-containing compounds such as titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, and polyhydroxy complexes of titanium. Zirconium crosslinks can be provided using zirconium IV-containing compounds such as zirconium lactate, zirconium carbonate, zirconium acetylacetonate, zirconium triethanolamine, zirconium diisopropylamine lactate and polyhydroxy complexes of zirconium, for example. Alternatively still, crosslinks can be provided using glyoxal, for example, such as disclosed in U.S. Patent Appl. Publ. No. 2008/0112907 which is incorporated herein by reference. Glyoxal can be applied under acidic conditions (e.g., slightly acidic conditions such as pH 5-6.5) in some aspects. Alternatively still, crosslinks can be provided with any crosslinking agent described in U.S. Patent Nos. 4462917, 4464270, 4477360 and 4799550, which are all incorporated herein by reference. A crosslinking agent (e.g., borate) may be present in an aqueous composition herein at a concentration of about 0.2% to 20 wt%, or about 0.1, 0.2, 0.3, 0.4, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, or 20 wt%, for example.

It is believed that a soy polysaccharide ether compound herein that is crosslinked typically has a higher viscosity in an aqueous composition compared to its non-crosslinked counterpart. In addition, it is believed that a crosslinked soy polysaccharide ether compound typically has increased shear thickening behavior compared to its non-crosslinked counterpart. An aqueous composition (e.g., hydrocolloid or aqueous solution) comprising a crosslinked soy polysaccharide ether compound herein can have a viscosity of at least about 50 cPs. Alternatively, such an aqueous composition can have a viscosity of at least about 50, 75, 100, 125, 150, 175, 200, 225, 250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 3000, 3500, or 4000 cPs (or any integer between 50 and 4000 cPs), for example.

An aqueous composition herein comprising a crosslinked soy polysaccharide ether compound can be in the form of a personal care product, pharmaceutical product, food product, household product, or industrial product, for example. Examples of such products are disclosed below.

Soy polysaccharide ether compounds disclosed herein may be crosslinked using any means known in the art. Such crosslinkage may be between the same soy polysaccharide ether compounds, or between two or more different soy polysaccharide ether compounds. Also, crosslinkage may be intermolecular and/or intramolecular.

A crosslinked soy polysaccharide ether compound can be prepared as follows, for example. One or more soy polysaccharide ether compounds can be dissolved in water or an aqueous solution to prepare a 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 wt% solution of the ether compound(s). Soy polysaccharide ether compound(s) can be dissolved or mixed using any process known in the art, such as by increasing temperature, manual mixing, and/or homogenization.

A crosslinking agent is next dissolved in the soy polysaccharide ether preparation. The concentration of the crosslinking agent in the resulting preparation can be about 0.2 to 20 wt%, or about 0.1, 0.2, 0.3, 0.4, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, or 20 wt%, for example.

The pH of the preparation containing both a crosslinking agent(s) and a soy polysaccharide ether compound(s) can be adjusted to be alkali (e.g., pH of 8, 8.5, 9, 9.5, or 10). Modification of pH can be done by any means known in the art, such as with a concentrated aqueous solution of an alkali hydroxide such as sodium hydroxide. Dissolving a crosslinking agent in a preparation containing one or more soy polysaccharide ether compounds at an alkali pH results in crosslinking of the soy polysaccharide ether compound(s).

A composition herein may optionally contain one or more active enzymes. Non-limiting examples of suitable enzymes include proteases, cellulases, hemicellulases, peroxidases, lipolytic enzymes (e.g., metallolipolytic enzymes), xylanases, lipases, phospholipases, esterases (e.g., arylesterase, polyesterase), perhydrolases, cutinases, pectinases, pectate lyases, mannanases, keratinases, reductases, oxidases (e.g., choline oxidase), phenoloxidases, lipoxygenases, ligninases, pullulanases, tannases, pentosanases, malanases, beta-glucanases, arabinosidases, hyaluronidases, chondroitinases, laccases, metalloproteinases, amadoriases, glucoamylases, arabinofuranosidases, phytases, isomerases, transferases and amylases. If an enzyme(s) is included, it may be comprised in a composition herein at about 0.0001-0.1 wt% (e.g., 0.01-0.03 wt%) active enzyme (e.g., calculated as pure enzyme protein), for example.

A cellulase herein can have endocellulase activity (EC 3.2.1.4), exocellulase activity (EC 3.2.1.91), or cellobiase activity (EC 3.2.1.21). A cellulase herein is an "active cellulase" having activity under suitable conditions for maintaining cellulase activity; it is within the skill of the art to determine such suitable conditions. Besides being able to degrade cellulose, a cellulase in certain embodiments can also degrade cellulose ether derivatives such as carboxymethyl cellulose. Examples of cellulose ether derivatives which are expected to not be stable to cellulase are disclosed in U.S. Patent Nos. 7012053, 7056880, 6579840, 7534759 and 7576048.

A cellulase herein may be derived from any microbial source, such as a bacteria or fungus. Chemically-modified cellulases or protein-engineered mutant cellulases are included. Suitable cellulases include, but are not limited to, cellulases from the genera *Bacillus*, *Pseudomonas*, *Streptomyces*, *Trichoderma*, *Humicola*, *Fusarium*, *Thielavia* and *Acremonium*. As other examples, a cellulase may be derived from *Humicola insolens*, *Myceliophthora thermophila* or *Fusarium oxysporum*; these and other cellulases are disclosed in U.S. Patent Nos. 4435307, 5648263, 5691178, 5776757 and 7604974, which are all incorporated herein by reference. Exemplary *Trichoderma reesei* cellulases are disclosed in U.S. Patent Nos. 4689297, 5814501, 5324649, and International Patent Appl. Publ. Nos. WO92/06221 and WO92/06165, all of which are incorporated herein by reference. Exemplary *Bacillus* cellulases are disclosed in U.S. Patent No. 6562612, which is incorporated herein by reference. A cellulase, such as any of the foregoing, preferably is in a mature form lacking an N-terminal signal peptide. Commercially available cellulases useful herein include CELLUZYME® and CAREZYME® (Novozymes A/S); CLAZINASE® and PURADAX® HA (DuPont Industrial Biosciences), and KAC-500(B)® (Kao Corporation).

Alternatively, a cellulase herein may be produced by any means known in the art, such as described in U.S. Patent Nos. 4435307, 5776757 and 7604974, which are incorporated herein by reference. For example, a cellulase may be produced recombinantly in a heterologous expression system, such as a microbial or fungal heterologous expression system. Examples of heterologous expression systems include bacterial (e.g., *E. coli*, *Bacillus* sp.) and eukaryotic systems. Eukaryotic systems can employ yeast (e.g., *Pichia* sp., *Saccharomyces* sp.) or fungal (e.g., *Trichoderma* sp. such as *T. reesei*, *Aspergillus* species such as *A. niger*) expression systems, for example.

One or more cellulases can be directly added as an ingredient when preparing a composition disclosed herein. Alternatively, one or more cellulases can be indirectly (inadvertently) provided in the disclosed composition. For example, cellulase can be provided in a composition herein by virtue of being present in a non-cellulase enzyme preparation used for preparing a composition. Cellulase in compositions in which cellulase is indirectly provided thereto can be present at about 0.1-10 ppb (e.g., less than 1 ppm), for example. A contemplated benefit of a composition herein, by virtue of employing a soy polysaccharide ether compound instead of a cellulose ether compound, is that non-cellulase enzyme preparations that might have background cellulase activity can be used without concern that the desired effects of the soy polysaccharide ether will be negated by the background cellulase activity.

A cellulase in certain embodiments can be thermostable. Cellulase thermostability refers to the ability of the enzyme to retain activity after exposure to an elevated temperature (e.g. about 60-70 °C) for a period of time (e.g., about 30-60 minutes). The thermostability of a cellulase can be measured by its half-life (t1/2) given in minutes, hours, or days, during which time period half the cellulase activity is lost under defined conditions.

A cellulase in certain embodiments can be stable to a wide range of pH values (e.g. neutral or alkaline pH such as pH of ~7.0 to ~11.0). Such enzymes can remain stable for a predetermined period of time (e.g., at least about 15 min., 30 min., or 1 hour) under such pH conditions.

At least one, two, or more cellulases may be included in a composition herein. The total amount of cellulase in a composition typically is an amount that is suitable for the purpose of using cellulase in the composition (an “effective amount”). For example, an effective amount of cellulase in a composition intended for improving the feel and/or appearance of a cellulose-containing fabric is an amount that produces measurable improvements in the feel of the fabric (e.g., improving fabric smoothness and/or appearance, removing pills and fibrils which tend to reduce fabric appearance sharpness). As another example, an effective amount of cellulase in a fabric stonewashing composition herein is that amount which will provide the desired effect (e.g., to produce a worn and faded look in seams and on fabric panels). The amount of cellulase in a composition herein can also depend on the process parameters in which the composition is employed (e.g., equipment, temperature, time, and the like) and cellulase activity, for example. The effective concentration of cellulase in an aqueous composition in which a fabric is treated can be readily determined by a skilled artisan. In fabric care processes, cellulase can be present in an aqueous composition (e.g., wash liquor) in which a fabric is treated in a concentration that is minimally about 0.01-0.1 ppm total cellulase protein, or about 0.1-10 ppb total cellulase protein (e.g., less than 1 ppm), to maximally about 100, 200, 500, 1000, 2000, 3000, 4000, or 5000 ppm total cellulase protein, for example.

Soy polysaccharide ethers herein are mostly or completely stable (resistant) to being degraded by cellulase. For example, the percent degradation of a soy polysaccharide ether compound by one or more cellulases is less than 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, or 1%, or is 0%. Such percent degradation can be determined, for example, by comparing the molecular weight of soy polysaccharide ether compound before and after treatment with a cellulase for a period of time (e.g., ~24 hours).

Aqueous compositions in certain embodiments are believed to have either shear thinning behavior or shear thickening behavior. Shear thinning behavior is observed as a decrease in viscosity of the aqueous composition as shear rate increases, whereas shear thickening behavior is observed as an increase in viscosity of the aqueous composition as shear rate increases. Modification of the shear thinning behavior or shear thickening behavior of an aqueous composition herein is due to the admixture of a soy polysaccharide ether to the aqueous composition. Thus, one or more soy polysaccharide ether compounds herein can be added to an aqueous composition to modify its rheological profile (i.e., the flow properties of an aqueous liquid, solution, or mixture are modified). Also, one or more soy polysaccharide ether compounds can be added to an aqueous composition to modify its viscosity in some aspects.

The rheological properties of aqueous compositions herein can be observed by measuring viscosity over an increasing rotational shear rate (e.g., from about 0.1 rpm to about 1000 rpm). For example, shear thinning behavior of an aqueous composition can be observed as a decrease in viscosity (cPs) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% (or any integer between 5% and 95%) as the rotational shear rate increases from about 10 rpm to 60 rpm, 10 rpm to 150 rpm, 10 rpm to 250 rpm, 60 rpm to 150 rpm, 60 rpm to 250 rpm, or 150 rpm to 250 rpm. As another example, shear thickening behavior of an aqueous composition can be observed as an increase in viscosity (cPs) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 175%, or 200% (or any integer between 5% and 200%) as the rotational shear rate increases from about 10 rpm to 60 rpm, 10 rpm to 150 rpm, 10 rpm to 250 rpm, 60 rpm to 150 rpm, 60 rpm to 250 rpm, or 150 rpm to 250 rpm.

An aqueous composition disclosed herein can be in the form of, and/or comprised in, a food product, personal care product, pharmaceutical product, household product, or industrial product, for example, such as any of those products described below. Soy polysaccharide ether compounds herein can be used as thickening agents in each of these products. Such a thickening agent may be used in conjunction with one or more other types of thickening agents if desired, such as those disclosed in U.S. Patent No. 8541041, which is incorporated herein by reference.

Personal care products herein are not particularly limited and include, for example, skin care compositions, cosmetic compositions, antifungal compositions, and antibacterial compositions. Personal care products herein may be in the form of, for example, lotions, creams, pastes, balms, ointments, pomades, gels, liquids, combinations of these and the like. The personal care products disclosed herein can include at least one active ingredient, if desired. An active ingredient is generally recognized as an ingredient that causes an intended pharmacological effect. A personal care product herein can be used in personal care cleaning applications in certain embodiments.

In certain embodiments, a skin care product can be applied to skin for addressing skin damage related to a lack of moisture. A skin care product may also be used to address the visual appearance of skin (e.g., reduce the appearance of flaky, cracked, and/or red skin) and/or the tactile feel of the skin (e.g., reduce roughness and/or dryness of the skin while improved the softness and subtleness of the skin). A skin care product typically may include at least one active ingredient for the treatment or prevention of skin ailments, providing a cosmetic effect, or for providing a moisturizing benefit to skin, such as zinc oxide, petrolatum, white petrolatum, mineral oil, cod liver oil, lanolin, dimethicone, hard fat, vitamin A, allantoin, calamine, kaolin, glycerin, or colloidal oatmeal, and combinations of these. A skin care product may include one or more natural moisturizing factors such as ceramides, hyaluronic acid, glycerin, squalane, amino acids, cholesterol, fatty acids, triglycerides, phospholipids, glycosphingolipids, urea, linoleic acid, glycosaminoglycans, mucopolysaccharide, sodium lactate, or sodium pyrrolidone carboxylate, for example. Other ingredients that may be included in a skin care product include, without limitation, glycerides, apricot kernel oil, canola oil, squalane, squalene, coconut oil, corn oil, jojoba oil, jojoba wax, lecithin, olive oil, safflower oil, sesame oil, shea butter, soybean oil, sweet almond oil, sunflower oil, tea tree oil, shea butter, palm oil, cholesterol, cholesterol esters, wax esters, fatty acids, and orange oil.

A personal care product herein can also be in the form of makeup, lipstick, mascara, rouge, foundation, blush, eyeliner, lip liner, lip gloss, other cosmetics, sunscreen, sun block, nail polish, nail conditioner, bath gel, shower gel, body wash, face wash, lip balm, skin conditioner, cold cream, moisturizer, body spray, soap, body scrub, exfoliant, astringent, scruffing lotion, depilatory, permanent waving solution, antidandruff formulation, antiperspirant composition, deodorant, shaving product, pre-shaving product, after-shaving product, cleanser, skin gel, rinse, dentifrice composition, toothpaste, or mouthwash, for example.

A personal care product in some aspects can be a hair care product. Examples of hair care products herein include shampoo, hair conditioner (leave-in or rinse-out), cream rinse, hair dye, hair coloring product, hair shine product, hair serum, hair anti-frizz product, hair split-end repair product, mousse, hair spray, and styling gel. A hair care product can be in the form of a liquid, paste, gel, solid, or powder in some embodiments. A hair care product as presently disclosed typically comprises one or more of the following ingredients, which are generally used to formulate hair care products: anionic surfactants such as polyoxyethylenelauryl ether sodium sulfate; cationic surfactants such as stearyltrimethylammonium chloride and/or distearyltrimethylammonium chloride; nonionic surfactants such as glyceryl monostearate, sorbitan monopalmitate and/or polyoxyethylenecetyl ether; wetting agents such as propylene glycol, 1,3-butylene glycol, glycerin, sorbitol, pyroglutamic acid salts, amino acids and/or trimethylglycine; hydrocarbons such as liquid paraffins, petrolatum, solid paraffins, squalane and/or olefin oligomers; higher alcohols such as stearyl alcohol and/or cetyl alcohol; superfatting agents; antidandruff agents; disinfectants; anti-inflammatory agents; crude drugs; water-soluble polymers such as methylcellulose, hydroxycellulose and/or partially deacetylated chitin (in addition to one or more soy polysaccharide ethers as disclosed herein); antiseptics such as paraben; ultra-violet light absorbers; pearling agents; pH adjustors; perfumes; and pigments.

A pharmaceutical product herein can be in the form of an emulsion, liquid, elixir, gel, suspension, solution, cream, or ointment, for example. Also, a pharmaceutical product herein can be in the form of any of the personal care products disclosed herein, such as an antibacterial or antifungal composition. A pharmaceutical product can further comprise one or more pharmaceutically acceptable carriers, diluents, and/or pharmaceutically acceptable salts. A soy polysaccharide ether compound disclosed herein can also be used in capsules, encapsulants, tablet coatings, and as an excipients for medicaments and drugs.

Non-limiting examples of food products herein include vegetable, meat, and soy patties; reformed seafood; reformed cheese sticks; cream soups; gravies and sauces; salad dressing; mayonnaise; onion rings; jams, jellies, and syrups; pie filling; potato products such as French fries and extruded fries; batters for fried foods, pancakes/waffles and cakes; pet foods; confectioneries (candy); beverages; frozen desserts; ice cream; cultured dairy products such as cottage cheese, yogurt, cheeses, and sour creams; cake icing and glazes; whipped topping; leavened and unleavened baked goods; bars; and the like.

Soy polysaccharide ether compounds disclosed herein can typically be used in a food product or any other ingestible material (e.g., enteral pharmaceutical preparation) at a level of about 0.01-10 wt%, 0.01-5 wt%, 0.1-3 wt%, 0.1-4 wt%, 0.1-5 wt%, or 0.1-10 wt%, for example.

A household and/or industrial product herein can be in the form of drywall tape-joint compounds; mortars; grouts; cement plasters; spray plasters; cement stucco;

adhesives; pastes; wall/ceiling texturizers; binders and processing aids for tape casting, extrusion forming, injection molding and ceramics; spray adherents and suspending/dispersing aids for pesticides, herbicides, and fertilizers; fabric care products such as fabric softeners and laundry detergents; dishwashing detergents; hard surface cleaners; air fresheners; polymer emulsions; gels such as water-based gels; surfactant solutions; paints such as water-based paints; protective coatings; adhesives; sealants and caulks; inks such as water-based ink; metal-working fluids; or emulsion-based metal cleaning fluids used in electroplating, phosphatizing, galvanizing and/or general metal cleaning operations, for example. A household product or industrial product herein can be used in cleaning applications in certain embodiments, and as such can be comprised in detergent compositions, for example.

A soy polysaccharide ether compound herein are believed to be useful for providing one or more of the following physical properties to a personal care product, pharmaceutical product, household product, industrial product, or food product: thickening, freeze/thaw stability, lubricity, moisture retention and release, texture, consistency, shape retention, emulsification, binding, suspension, dispersion, gelation, reduced mineral hardness, for example. Examples of a concentration or amount of a soy polysaccharide ether compound in a product can be any of the weight percentages provided above, for example.

A food product herein can be in the form of a confectionery, for example. A confectionary herein can contain one or more sugars (e.g., sucrose, fructose, dextrose) for sweetening, or otherwise be sugar-free.

Examples of confectioneries herein include boiled sugars (hard boiled candies [i.e., hard candy]), dragees, jelly candies, gums, licorice, chews, caramels, toffee, fudge, chewing gums, bubble gums, nougat, chewy pastes, halawa, tablets, lozenges, icing, frosting, pudding, and gels (e.g., fruit gels, gelatin dessert). Other examples of confectioneries include aerated confectioneries such as marshmallows, and baked confectioneries.

A confectionery herein can optionally be prepared with chocolate, in any form (e.g., bars, candies, bonbons, truffles, lentils). A confectionary can be coated with chocolate, sugar-coated, candied, glazed, and/or film-coated, for example. Film-coating processes typically comprise applying to the surface of a confectionery a film-forming liquid composition which becomes, after drying, a protective film. This film-coating serves, for example, to protect the active principles contained in the confectionery; to protect the confectionery itself from moisture, shocks, and/or friability; and/or to confer the confectionery attractive visual properties (e.g., shine, uniform color, smooth surface).

In certain embodiments, a confectionery can be filled with a filling that is liquid, pasty, solid, or powdered. A soy polysaccharide ether compound herein can be comprised in such a filling, in which case the ether compound is optionally also included in the confectionery component being filled.

A confectionery herein is optionally sugar-free, comprising no sugar and typically instead having one or more artificial and/or non-sugar sweeteners (optionally non-caloric) (e.g., aspartame, saccharin, STEVIA, SUCRALOSE). A sugar-free confectionery in certain embodiments can comprise one or more polyols (e.g., erythritol, glycerol, lactitol, mannitol, maltitol, xylitol), soluble fibers, and/or proteins in place of sugar.

A food product herein can be in the form of a pet food, for example. A pet food herein can be a food for a domesticated animal such as a dog or cat (or any other companion animal), for example. A pet food in certain embodiments provides to a domestic animal one or more of the following: necessary dietary requirements, treats (e.g., dog biscuits), food supplements. Examples of pet food include dry pet food (e.g., kernels, kibbles), semi-moist compositions, wet pet food (e.g., canned pet food), or any combination thereof. Wet pet food typically has a moisture content over 65%. Semi-moist pet food typically has a moisture content of 20-65% and can include humectants such as propylene glycol, potassium sorbate, and ingredients that prevent microbial growth (bacteria and mold). Dry pet food typically has a moisture content less than 20% and its processing usually includes extruding, drying and/or baking. A pet food can optionally be in the form of a gravy, yogurt, powder, suspension, chew, or treat (e.g., biscuits); all these compositions can also be used as pet food supplements, if desired. Pet treats can be semi-moist chewable treats; dry treats; chewable bones; baked, extruded or stamped treats; or confection treats, for example. Examples of pet food compositions/formulations in which a soy polysaccharide ether compound herein can be added include those disclosed in U.S. Patent Appl. Publ. Nos. 2013/0280352 and 2010/0159103, and U.S. Patent No. 6977084, which are all incorporated herein by reference.

Compositions disclosed herein can be in the form of a fabric care composition. A fabric care composition herein can be used for hand wash, machine wash and/or other purposes such as soaking and/or pretreatment of fabrics, for example. A fabric care composition may take the form of, for example, a laundry detergent; fabric conditioner; any wash-, rinse-, or dryer-added product; unit dose or spray. Fabric care compositions in a liquid form may be in the form of an aqueous composition as disclosed herein. In other aspects, a fabric care composition can be in a dry form such as a granular detergent or dryer-added fabric softener sheet. Other non-limiting examples of fabric care compositions herein include: granular or powder-form all-purpose or heavy-duty washing agents; liquid, gel or paste-form all-purpose or heavy-duty washing agents; liquid or dry fine-fabric (e.g. delicates) detergents; cleaning auxiliaries such as bleach additives, “stain-stick”, or pre-treatments; substrate-laden products such as dry and wetted wipes, pads, or sponges; sprays and mists.

A detergent composition herein may be in any useful form, e.g., as powders, granules, pastes, bars, unit dose, or liquid. A liquid detergent may be aqueous, typically containing up to about 70 wt% of water and 0 wt% to about 30 wt% of organic solvent. It may also be in the form of a compact gel type containing only about 30 wt% water.

A detergent composition herein typically comprises one or more surfactants, wherein the surfactant is selected from nonionic surfactants, anionic surfactants, cationic surfactants, ampholytic surfactants, zwitterionic surfactants, semi-polar nonionic surfactants and mixtures thereof. In some embodiments, the surfactant is present at a level of from about 0.1% to about 60%, while in alternative embodiments the level is from about 1% to about 50%, while in still further embodiments the level is from about 5% to about 40%, by weight of the detergent composition. A detergent will usually contain 0 wt% to about 50 wt% of an anionic surfactant such as linear alkylbenzenesulfonate (LAS), alpha-olefinsulfonate (AOS), alkyl sulfate (fatty alcohol sulfate) (AS), alcohol ethoxysulfate (AEOS or AES), secondary alkanesulfonates (SAS), alpha-sulfo fatty acid methyl esters, alkyl- or alkenylsuccinic acid, or soap. In addition, a detergent composition may optionally contain 0 wt% to about 40 wt% of a nonionic surfactant such as alcohol ethoxylate (AEO or AE), carboxylated alcohol ethoxylates, nonylphenol ethoxylate, alkylpolyglycoside, alkyldimethylamineoxide, ethoxylated fatty acid monoethanolamide, fatty acid monoethanolamide, or polyhydroxy alkyl fatty acid amide (as described for example in WO92/06154, which is incorporated herein by reference).

A detergent composition herein typically comprises one or more detergent builders or builder systems. In some embodiments incorporating at least one builder, the cleaning compositions comprise at least about 1%, from about 3% to about 60%, or even from about 5% to about 40%, builder by weight of the composition. Builders include, but are not limited to, alkali metal, ammonium and alkanolammonium salts of polyphosphates, alkali metal silicates, alkaline earth and alkali metal carbonates, aluminosilicates, polycarboxylate compounds, ether hydroxypolycarboxylates, copolymers of maleic anhydride with ethylene or vinyl methyl ether, 1, 3, 5-trihydroxy benzene-2, 4, 6-trisulphonic acid, and carboxymethyloxysuccinic acid, various alkali metal, ammonium and substituted ammonium salts of polyacetic acids such as ethylenediamine tetraacetic acid and nitrilotriacetic acid, as well as polycarboxylates such as mellitic acid, succinic acid, citric acid, oxydisuccinic acid, polymaleic acid, benzene 1,3,5-tricarboxylic acid, carboxymethyloxysuccinic acid, and soluble salts thereof. Indeed, it is contemplated that any suitable builder will find use in various embodiments of the present disclosure. Examples of a detergent builder or complexing agent include zeolite, diphosphate, triphosphate, phosphonate, citrate, nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTMPA), alkyl- or alkenylsuccinic acid, soluble silicates or layered silicates (e.g., SKS-6 from Hoechst).

In some embodiments, builders form water-soluble hardness ion complexes (e.g., sequestering builders), such as citrates and polyphosphates (e.g., sodium tripolyphosphate and sodium tripolyphospate hexahydrate, potassium tripolyphosphate, and mixed sodium and potassium tripolyphosphate, etc.). It is contemplated that any suitable builder will find use in the present disclosure, including those known in the art (See, e.g., EP2100949).

In some embodiments, suitable builders include phosphate builders and non-phosphate builders. In some embodiments, a builder is a phosphate builder. In some embodiments, a builder is a non-phosphate builder. A builder can be used in a level of from 0.1% to 80%, or from 5% to 60%, or from 10% to 50%, by weight of the composition. In some embodiments, the product comprises a mixture of phosphate and non-phosphate builders. Suitable phosphate builders include mono-phosphates, di-phosphates, tri-polyphosphates or oligomeric-polyphosphates, including the alkali metal salts of these compounds, including the sodium salts. In some embodiments, a builder can be sodium tripolyphosphate (STPP). Additionally, the composition can comprise carbonate and/or citrate, preferably citrate that helps to achieve a neutral pH composition. Other suitable non-phosphate builders include homopolymers and copolymers of polycarboxylic acids and their partially or completely neutralized salts, monomeric polycarboxylic acids and hydroxycarboxylic acids and their salts. In some embodiments, salts of the above mentioned compounds include ammonium and/or alkali metal salts, i.e., lithium, sodium, and potassium salts, including sodium salts. Suitable polycarboxylic acids include acyclic, alicyclic, hetero-cyclic and aromatic carboxylic acids, wherein in some embodiments, they can contain at least two carboxyl groups which are in each case separated from one another by, in some instances, no more than two carbon atoms.

A detergent composition herein can comprise at least one chelating agent. Suitable chelating agents include, but are not limited to copper, iron and/or manganese chelating agents and mixtures thereof. In embodiments in which at least one chelating agent is used, the composition comprises from about 0.1% to about 15%, or even from about 3.0% to about 10%, chelating agent by weight of the composition.

A detergent composition herein can comprise at least one deposition aid. Suitable deposition aids include, but are not limited to, polyethylene glycol, polypropylene glycol, polycarboxylate, soil release polymers such as polytelephthalic acid, clays such as kaolinite, montmorillonite, atapulgite, illite, bentonite, halloysite, and mixtures thereof.

A detergent composition herein can comprise one or more dye transfer inhibiting agents. Suitable polymeric dye transfer inhibiting agents include, but are not limited to, polyvinylpyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinyloxazolidones and polyvinylimidazoles or mixtures thereof. Additional dye transfer inhibiting agents include manganese phthalocyanine, peroxidases, polyvinylpyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinyloxazolidones and polyvinylimidazoles and/or mixtures thereof; chelating agents examples of which include ethylene-diamine-tetraacetic acid (EDTA); diethylene triamine penta methylene phosphonic acid (DTPMP); hydroxy-ethane diphosphonic acid (HEDP); ethylenediamine

N,N'-disuccinic acid (EDDS); methyl glycine diacetic acid (MGDA); diethylene triamine penta acetic acid (DTPA); propylene diamine tetracetic acid (PDT A); 2-hydroxypyridine-N-oxide (HPNO); or methyl glycine diacetic acid (MGDA); glutamic acid N,N-diacetic acid (N,N-dicarboxymethyl glutamic acid tetrasodium salt (GLDA); nitrilotriacetic acid (NTA); 4,5-dihydroxy-m-benzenedisulfonic acid; citric acid and any salts thereof; N-hydroxyethyl ethylenediaminetri-acetic acid (HEDTA), triethylenetetraaminehexaacetic acid (TTHA), N-hydroxyethyliminodiacetic acid (HEIDA), dihydroxyethylglycine (DHEG), ethylenediaminetetrapropionic acid (EDTP) and derivatives thereof, which can be used alone or in combination with any of the above. In embodiments in which at least one dye transfer inhibiting agent is used, a composition herein may comprise from about 0.0001% to about 10%, from about 0.01% to about 5%, or even from about 0.1% to about 3%, by weight of the composition.

A detergent composition herein can comprise silicates. In some of these embodiments, sodium silicates (e.g., sodium disilicate, sodium metasilicate, and/or crystalline phyllosilicates) find use. In some embodiments, silicates are present at a level of from about 1% to about 20% by weight of the composition. In some embodiments, silicates are present at a level of from about 5% to about 15% by weight of the composition.

A detergent composition herein can comprise dispersants. Suitable water-soluble organic materials include, but are not limited to the homo- or co-polymeric acids or their salts, in which the polycarboxylic acid comprises at least two carboxyl radicals separated from each other by not more than two carbon atoms.

A detergent composition herein may additionally comprise one or more enzymes. Examples of enzymes include proteases, cellulases, hemicellulases, peroxidases, lipolytic enzymes (e.g., metallolipolytic enzymes), xylanases, lipases, phospholipases, esterases (e.g., arylesterase, polyesterase), perhydrolases, cutinases, pectinases, pectate lyases, mannanases, keratinases, reductases, oxidases (e.g., choline oxidase, phenoloxidase), phenoloxidases, lipoxygenases, ligninases, pullulanases, tannases, pentosanases, malanases, beta-glucanases, arabinosidases, hyaluronidases, chondroitinases, laccases, metalloproteinases, amadoriases, glucoamylases, alpha-amylases, beta-amylases, galactosidases, galactanases, catalases, carageenases, hyaluronidases, keratinases, lactases, ligninases, peroxidases, phosphatases, polygalacturonases, pullulanases, rhamnogalactouronases, tannases, transglutaminases, xyloglucanases, xylosidases, metalloproteases, arabinofuranosidases, phytases, isomerases, transferases and/or amylases in any combination.

Any cellulase disclosed above is contemplated for use in the disclosed detergent compositions. Suitable cellulases include, but are not limited to Humicola insolens cellulases (See e.g., U.S. Pat. No. 4435307). Exemplary cellulases contemplated for use herein are those having color care benefit for a textile. Examples of cellulases that provide a color care benefit are disclosed in EP0495257, EP0531372, EP531315, WO96/11262, WO96/29397, WO94/07998; WO98/12307; WO95/24471, WO98/08940, and U.S. Patent Nos. 5457046, 5686593 and 5763254,all of which are incorporated herein by reference. Examples of commercially available cellulases useful in a detergent include CELLUSOFT®, CELLUCLEAN®, CELLUZYME®, and CAREZYME® (Novo Nordisk A/S and Novozymes A/S); CLAZINASE®, PURADAX HA®, and REVITALENZ™ (DuPont Industrial Biosciences); BIOTOUCH® (AB Enzymes); and KAC-500(B)™ (Kao Corporation). Additional cellulases are disclosed in, e.g., US7595182, US8569033, US7138263, US3844890, US4435307, US4435307, and GB2095275.

In some embodiments, a detergent composition can comprise one or more enzymes (e.g., any disclosed herein), each at a level from about 0.00001% to about 10% by weight of the composition and the balance of cleaning adjunct materials by weight of composition. In some other embodiments, a detergent composition can also comprise each enzyme at a level of about 0.0001% to about 10%, about 0.001% to about 5%, about 0.001% to about 2%, or about 0.005% to about 0.5%, by weight of the composition.

Suitable proteases include those of animal, vegetable or microbial origin. In some embodiments, microbial proteases are used. In some embodiments, chemically or genetically modified mutants are included. In some embodiments, the protease is a serine protease, preferably an alkaline microbial protease or a trypsin-like protease. Examples of alkaline proteases include subtilisins, especially those derived from Bacillus (e.g., subtilisin, lentus, amyloliquefaciens, subtilisin Carlsberg, subtilisin 309, subtilisin 147 and subtilisin 168). Additional examples include those mutant proteases described in U.S. Pat. Nos. RE34606, 5955340, 5700676, 6312936 and 6482628, all of which are incorporated herein by reference. Additional protease examples include, but are not limited to, trypsin (e.g., of porcine or bovine origin), and the Fusarium protease described in WO89/06270. In some embodiments, commercially available protease enzymes include, but are not limited to, MAXATASE®, MAXACAL™, MAXAPEM™, OPTICLEAN®, OPTIMASE®, PROPERASE®, PURAFECT®, PURAFECT® OXP, PURAMAX™, EXCELLASE™, PREFERENZ™ proteases (e.g. P100, P110, P280), EFFECTENZ™ proteases (e.g. P1000, P1050, P2000), EXCELLENZ™ proteases (e.g. P1000), ULTIMASE®, and PURAFAST™ (Genencor); ALCALASE®, SAVINASE®, PRIMASE®, DURAZYM™, POLARZYME®, OVOZYME®, KANNASE®, LIQUANASE®, NEUTRASE®, RELASE® and ESPERASE® (Novozymes); BLAP™ and BLAP™ variants (Henkel Kommanditgesellschaft auf Aktien, Duesseldorf, Germany), and KAP (B. alkalophilus subtilisin; Kao Corp., Tokyo, Japan). Various proteases are described in WO95/23221, WO92/21760, WO09/149200, WO09/149144, WO09/149145, WO11/072099, WO10/056640, WO10/056653, WO11/140364, WO12/151534, U.S. Pat. Publ. No. 2008/0090747, and U.S. Pat. Nos. 5801039, 5340735, 5500364, 5855625, RE34606, 5955340, 5700676, 6312936, 6482628, 8530219, and various other patents. In some further embodiments, neutral metalloproteases find use in the present disclosure, including but not limited to, the neutral metalloproteases described in WO1999014341, WO1999033960, WO1999014342, WO1999034003, WO2007044993, WO2009058303 and WO2009058661, all of which are incorporated herein by reference. Exemplary metalloproteases include nprE, the recombinant form of neutral metalloprotease expressed in Bacillus subtilis (See e.g., WO07/044993), and PMN, the purified neutral metalloprotease from Bacillus amyloliquefaciens.

Suitable mannanases include, but are not limited to, those of bacterial or fungal origin. Chemically or genetically modified mutants are included in some embodiments. Various mannanases are known which find use in the present disclosure (See, e.g., U.S. Pat. Nos. 6566114, 6602842, and 6440991, all of which are incorporated herein by reference). Commercially available mannanases that find use in the present disclosure include, but are not limited to MANNASTAR®, PURABRITE™, and MANNAWAY®.

Suitable lipases include those of bacterial or fungal origin. Chemically modified, proteolytically modified, or protein engineered mutants are included. Examples of useful lipases include those from the genera *Humicola* (e.g., *H. lanuginosa*, EP258068 and EP305216; *H. insolens*, WO96/13580), *Pseudomonas* (e.g., *P. alcaligenes* or *P. pseudoalcaligenes*, EP218272; *P. cepacia*, EP331376; *P. stutzeri*, GB1372034; *P.*

fluorescens and *Pseudomonas* sp. strain SD 705, WO95/06720 and WO96/27002; *P. wisconsinensis*, WO96/12012); and *Bacillus* (e.g., *B. subtilis*, Dartois et al., *Biochemica et Biophysica Acta* 1131:253-360; *B. stearothermophilus*, JP64/744992; *B. pumilus*, WO91/16422). Furthermore, a number of cloned lipases find use in some embodiments of the present disclosure, including but not limited to, Penicillium camembertii lipase (See, Yamaguchi et al., Gene 103:61-67 [1991]), Geotricum candidum lipase (See, Schimada et al., J. Biochem., 106:383-388 [1989]), and various Rhizopus lipases such as R. delemar lipase (See, Hass et al., Gene 109:117-113 [1991]), a R. niveus lipase (Kugimiya et al., Biosci. Biotech. Biochem. 56:716-719 [1992]) and R. oryzae lipase. Additional lipases useful herein include, for example, those disclosed in WO92/05249, WO94/01541, WO95/35381, WO96/00292, WO95/30744, WO94/25578, WO95/14783, WO95/22615, WO97/04079, WO97/07202, EP407225 and EP260105. Other types of lipase polypeptide enzymes such as cutinases also find use in some embodiments of the present disclosure, including but not limited to, cutinase derived from Pseudomonas mendocina (See, WO88/09367), and cutinase derived from Fusarium solani pisi (See, WO90/09446). Examples of certain commercially available lipase enzymes useful herein include M1 LIPASE™, LUMA FAST™, and LIPOMAX™ (Genencor); LIPEX®, LIPOLASE® and LIPOLASE® ULTRA (Novozymes); and LIPASE P™ "Amano" (Amano Pharmaceutical Co. Ltd., Japan).

Suitable polyesterases include, for example, those disclosed in WO01/34899, WO01/14629 and U.S. Patent No. 6933140.

A detergent composition herein can also comprise 2,6-beta-D-fructan hydrolase, which is effective for removal/cleaning of certain biofilms present on household and/or industrial textiles/laundry.

Suitable amylases include, but are not limited to those of bacterial or fungal origin. Chemically or genetically modified mutants are included in some embodiments. Amylases that find use in the present disclosure, include, but are not limited to, alpha-amylases obtained from B. licheniformis (See e.g., GB1296839). Additional suitable amylases include those disclosed in W09510603, WO9526397, WO9623874, WO9623873, WO9741213, WO9919467, WO0060060, WO0029560, WO9923211, WO9946399, WO0060058, WO0060059, WO9942567, WO0114532, WO02092797, WO0166712, WO0188107, WO0196537, WO0210355, WO9402597, WO0231124, WO9943793, WO9943794, WO2004113551, WO2005001064, WO2005003311, WO0164852, WO2006063594, WO2006066594, WO2006066596, WO2006012899, WO2008092919, WO2008000825, WO2005018336, WO2005066338, WO2009140504, WO2005019443, WO2010091221, WO2010088447, WO0134784, WO2006012902, WO2006031554, WO2006136161, WO2008101894, WO2010059413, WO2011098531, WO2011080352, WO2011080353, WO2011080354, WO2011082425, WO2011082429, WO2011076123, WO2011087836, WO2011076897, WO94183314, WO9535382, WO9909183, WO9826078, WO9902702, WO9743424, WO9929876, WO9100353, WO9605295, WO9630481, WO9710342, WO2008088493, WO2009149419, WO2009061381, WO2009100102, WO2010104675, WO2010117511, and WO2010115021, all of which are incorporated herein by reference.

Suitable amylases include, for example, commercially available amylases such as STAINZYME®, STAINZYME PLUS®, NATALASE®, DURAMYL®, TERMAMYL®, TERMAMYL ULTRA®, FUNGAMYL® and BAN™ (Novo Nordisk A/S and Novozymes A/S); RAPIDASE®, POWERASE®, PURASTAR® and PREFERENZ™ (DuPont Industrial Biosciences).

Suitable peroxidases/oxidases contemplated for use in the compositions include those of plant, bacterial or fungal origin. Chemically modified or protein engineered mutants are included. Examples of peroxidases useful herein include those from the genus *Coprinus* (e.g., *C. cinereus*, WO93/24618, WO95/10602, and WO98/15257), as well as those referenced in WO2005056782, WO2007106293, WO2008063400, WO2008106214, and WO2008106215. Commercially available peroxidases useful herein include, for example, GUARDZYME™ (Novo Nordisk A/S and Novozymes A/S).

In some embodiments, peroxidases are used in combination with hydrogen peroxide or a source thereof (e.g., a percarbonate, perborate or persulfate) in the compositions of the present disclosure. In some alternative embodiments, oxidases are used in combination with oxygen. Both types of enzymes are used for “solution bleaching” (i.e., to prevent transfer of a textile dye from a dyed fabric to another fabric when the fabrics are washed together in a wash liquor), preferably together with an enhancing agent (See e.g., WO94/12621 and WO95/01426). Suitable peroxidases/oxidases include, but are not limited to, those of plant, bacterial or fungal origin. Chemically or genetically modified mutants are included in some embodiments.

Enzymes that may be comprised in a detergent composition herein may be stabilized using conventional stabilizing agents, e.g., a polyol such as propylene glycol or glycerol; a sugar or sugar alcohol; lactic acid; boric acid or a boric acid derivative (e.g., an aromatic borate ester).

A detergent composition herein may contain about 1 wt% to about 65 wt% of a detergent builder or complexing agent such as zeolite, diphosphate, triphosphate, phosphonate, citrate, nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTMPA), alkyl- or alkenylsuccinic acid, soluble silicates or layered silicates (e.g., SKS-6 from Hoechst). A detergent may also be unbuilt, i.e., essentially free of detergent builder.

A detergent composition in certain embodiments may comprise one or more other types of polymers in addition to a soy polysaccharide ether compound as disclosed herein. Examples of other types of polymers useful herein include carboxymethyl cellulose (CMC), poly(vinylpyrrolidone) (PVP), polyethylene glycol (PEG), poly(vinyl alcohol) (PVA), polycarboxylates such as polyacrylates, maleic/acrylic acid copolymers and lauryl methacrylate/acrylic acid copolymers.

A detergent composition herein may contain a bleaching system. For example, a bleaching system can comprise an H_2O_2 source such as perborate or percarbonate, which may be combined with a peracid-forming bleach activator such as tetraacetylethylenediamine (TAED) or nonanoyloxybenzenesulfonate (NOBS). Alternatively, a bleaching system may comprise peroxyacids (e.g., amide, imide, or sulfone type peroxyacids). Alternatively still, a bleaching system can be an enzymatic bleaching system comprising perhydrolase, for example, such as the system described in WO2005/056783.

A detergent composition herein may also contain conventional detergent ingredients such as fabric conditioners, clays, foam boosters, suds suppressors, anti-corrosion agents, soil-suspending agents, anti-soil redeposition agents, dyes, bactericides, tarnish inhibiters, optical brighteners, or perfumes. The pH of a detergent composition herein (measured in aqueous solution at use concentration) is usually neutral or alkaline (e.g., pH of about 7.0 to about 11.0).

It is believed that a soy polysaccharide ether herein can be included as an anti-redeposition agent and/or clay soil removal agent in a detergent composition such as a fabric care composition, if desired (such agents can optionally be characterized as whiteness maintenance agents in certain aspects). Examples of other suitable anti-redeposition and/or clay soil removal agents herein include polyethoxy zwitterionic surfactants, water-soluble copolymers of acrylic or methacrylic acid with acrylic or methacrylic acid-ethylene oxide condensates (e.g., U.S. Pat. No. 3719647), cellulose derivatives such as carboxymethylcellulose and hydroxypropylcellulose (e.g., U.S. Pat. Nos. 3597416 and 3523088), and mixtures comprising nonionic alkyl polyethoxy surfactant, polyethoxy alkyl quaternary cationic surfactant and fatty amide surfactant (e.g., U.S. Pat. No. 4228044). Non-limiting examples of other suitable anti-redeposition and clay soil removal agents are disclosed in U.S. Pat. Nos. 4597898 and 4891160, and Int. Pat. Appl. Publ. No. WO95/32272, all of which are incorporated herein by reference.

Particular forms of detergent compositions that can be adapted for purposes disclosed herein are disclosed in, for example, US20090209445A1, US20100081598A1, US7001878B2, EP1504994B1, WO2001085888A2, WO2003089562A1, WO2009098659A1, WO2009098660A1, WO2009112992A1, WO2009124160A1, WO2009152031A1, WO2010059483A1, WO2010088112A1, WO2010090915A1, WO2010135238A1, WO2011094687A1, WO2011094690A1, WO2011127102A1, WO2011163428A1, WO2008000567A1, WO2006045391A1, WO2006007911A1, WO2012027404A1, EP1740690B1, WO2012059336A1, US6730646B1, WO2008087426A1, WO2010116139A1, and WO2012104613A1, all of which are incorporated herein by reference.

Laundry detergent compositions herein can optionally be heavy duty (all purpose) laundry detergent compositions. Exemplary heavy duty laundry detergent compositions comprise a detersive surfactant (10%-40% wt/wt), including an anionic detersive surfactant (selected from a group of linear or branched or random chain, substituted or unsubstituted alkyl sulphates, alkyl sulphonates, alkyl alkoxylated sulphate, alkyl phosphates, alkyl phosphonates, alkyl carboxylates, and/or mixtures thereof), and optionally non-ionic surfactant (selected from a group of linear or branched or random chain, substituted or unsubstituted alkyl alkoxylated alcohol, e.g., C8-C18 alkyl ethoxylated alcohols and/or C6-C12 alkyl phenol alkoxylates), where the weight ratio of anionic detersive surfactant (with a hydrophilic index (HIc) of from 6.0 to 9) to non-ionic detersive surfactant is greater than 1:1. Suitable detersive surfactants also include cationic detersive surfactants (selected from a group of alkyl pyridinium compounds, alkyl quaternary ammonium compounds, alkyl quaternary phosphonium compounds, alkyl ternary sulphonium compounds, and/or mixtures thereof); zwitterionic and/or amphoteric detersive surfactants (selected from a group of alkanolamine sulpho-betaines); ampholytic surfactants; semi-polar non-ionic surfactants and mixtures thereof.

A detergent herein such as a heavy duty laundry detergent composition may optionally include, a surfactancy boosting polymer consisting of amphiphilic alkoxylated grease cleaning polymers (selected from a group of alkoxylated polymers having branched hydrophilic and hydrophobic properties, such as alkoxylated polyalkylenimines in the range of 0.05 wt% - 10 wt%) and/or random graft polymers (typically comprising of hydrophilic backbone comprising monomers selected from the group consisting of: unsaturated C1-C6 carboxylic acids, ethers, alcohols, aldehydes, ketones, esters, sugar units, alkoxy units, maleic anhydride, saturated polyalcohols such as glycerol, and mixtures thereof; and hydrophobic side chain(s) selected from the group consisting of: C4-C25 alkyl group, polypropylene, polybutylene, vinyl ester of a saturated C1-C6 mono-carboxylic acid, C1-C6 alkyl ester of acrylic or methacrylic acid, and mixtures thereof.

A detergent herein such as a heavy duty laundry detergent composition may optionally include additional polymers such as soil release polymers (include anionically end-capped polyesters, for example SRP1, polymers comprising at least one monomer unit selected from saccharide, dicarboxylic acid, polyol and combinations thereof, in random or block configuration, ethylene terephthalate-based polymers and co-polymers thereof in random or block configuration, for example REPEL-O-TEX SF, SF-2 AND SRP6, TEXCARE SRA100, SRA300, SRN100, SRN170, SRN240, SRN300 AND SRN325, MARLOQUEST SL), anti-redeposition agents(s) herein (0.1 wt% to 10 wt%), include carboxylate polymers, such as polymers comprising at least one monomer selected from acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid, methylenemalonic acid, and any mixture thereof, vinylpyrrolidone homopolymer, and/or polyethylene glycol, molecular weight in the range of from 500 to 100,000 Da); and polymeric carboxylate (such as maleate/acrylate random copolymer or polyacrylate homopolymer).

A detergent herein such as a heavy duty laundry detergent composition may optionally further include saturated or unsaturated fatty acids, preferably saturated or unsaturated C12-C24 fatty acids (0 wt% to 10 wt%); deposition aids in addition to a soy polysaccharide ether compound disclosed herein (examples for which include polysaccharides, cellulosic polymers, poly diallyl dimethyl ammonium halides

(DADMAC), and co-polymers of DAD MAC with vinyl pyrrolidone, acrylamides, imidazoles, imidazolinium halides, and mixtures thereof, in random or block configuration, cationic guar gum, cationic starch, cationic polyacylamides, and mixtures thereof.

A detergent herein such as a heavy duty laundry detergent composition may optionally further include dye transfer inhibiting agents, examples of which include manganese phthalocyanine, peroxidases, polyvinylpyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinyloxazolidones and polyvinylimidazoles and/or mixtures thereof; chelating agents, examples of which include ethylene-diamine-tetraacetic acid (EDTA), diethylene triamine penta methylene phosphonic acid (DTPMP), hydroxy-ethane diphosphonic acid (HEDP), ethylenediamine N,N'-disuccinic acid (EDDS), methyl glycine diacetic acid (MGDA), diethylene triamine penta acetic acid (DTPA), propylene diamine tetracetic acid (PDTA), 2-hydroxypyridine-N-oxide (HPNO), or methyl glycine diacetic acid (MGDA), glutamic acid N,N-diacetic acid (N,N-dicarboxymethyl glutamic acid tetrasodium salt (GLDA), nitrilotriacetic acid (NTA), 4,5-dihydroxy-m-benzenedisulfonic acid, citric acid and any salts thereof, N-hydroxyethylethylenediaminetriacetic acid (HEDTA), triethylenetetraaminehexaacetic acid (TTHA), N-hydroxyethyliminodiacetic acid (HEIDA), dihydroxyethylglycine (DHEG), ethylenediaminetetrapropionic acid (EDTP), and derivatives thereof.

A detergent herein such as a heavy duty laundry detergent composition may optionally include silicone or fatty-acid based suds suppressors; hueing dyes, calcium and magnesium cations, visual signaling ingredients, anti-foam (0.001 wt% to about 4.0 wt%), and/or a structurant/thickener (0.01 wt% to 5 wt%) selected from the group consisting of diglycerides and triglycerides, ethylene glycol distearate, microcrystalline cellulose, microfiber cellulose, biopolymers, xanthan gum, gellan gum, and mixtures thereof). Such structurant/thickener would be in addition to the one or more soy polysaccharide ether compounds comprised in the detergent. A structurant can also be referred to as a structural agent.

A detergent herein can be in the form of a heavy duty dry/solid laundry detergent composition, for example. Such a detergent may include: (i) a detersive surfactant, such as any anionic detersive surfactant disclosed herein, any non-ionic detersive surfactant disclosed herein, any cationic detersive surfactant disclosed herein, any zwitterionic and/or amphoteric detersive surfactant disclosed herein, any ampholytic surfactant, any semi-polar non-ionic surfactant, and mixtures thereof; (ii) a builder, such as any phosphate-free builder (e.g., zeolite builders in the range of 0 wt% to less than 10 wt%), any phosphate builder (e.g., sodium tri-polyphosphate in the range of 0 wt% to less than 10 wt%), citric acid, citrate salts and nitrilotriacetic acid, any silicate salt (e.g., sodium or potassium silicate or sodium meta-silicate in the range of 0 wt% to less than 10 wt%); any carbonate salt (e.g., sodium carbonate and/or sodium bicarbonate in the range of 0 wt% to less than 80 wt%), and mixtures thereof; (iii) a bleaching agent, such as any photobleach (e.g., sulfonated zinc phthalocyanines, sulfonated aluminum phthalocyanines, xanthenes dyes, and mixtures thereof), any hydrophobic or hydrophilic bleach activator (e.g., dodecanoyl oxybenzene sulfonate, decanoyl oxybenzene sulfonate, decanoyl oxybenzoic acid or salts thereof, 3,5,5-trimethy hexanoyl oxybenzene sulfonate, tetraacetyl ethylene diamine-TAED, nonanoyloxybenzene sulfonate-NOBS, nitrile quats, and mixtures thereof), any source of hydrogen peroxide (e.g., inorganic perhydrate salts, examples of which include mono or tetra hydrate sodium salt of perborate, percarbonate, persulfate, perphosphate, or persilicate), any preformed hydrophilic and/or hydrophobic peracids (e.g., percarboxylic acids and salts, percarbonic acids and salts, perimidic acids and salts, peroxymonosulfuric acids and salts, and mixtures thereof); and/or (iv) any other components such as a bleach catalyst (e.g., imine bleach boosters examples of which include iminium cations and polyions, iminium zwitterions, modified amines, modified amine oxides, N-sulphonyl imines, N-phosphonyl imines, N-acyl imines, thiadiazole dioxides, perfluoroimines, cyclic sugar ketones, and mixtures thereof), and a metal-containing bleach catalyst (e.g., copper, iron, titanium, ruthenium, tungsten, molybdenum, or manganese cations along with an auxiliary metal cations such as zinc or aluminum and a sequestrate such as EDTA, ethylenediaminetetra(methylenephosphonic acid).

Compositions disclosed herein can be in the form of a dishwashing detergent composition, for example. Examples of dishwashing detergents include automatic dishwashing detergents (typically used in dishwasher machines) and hand-washing dish detergents. A dishwashing detergent composition can be in any dry or liquid/aqueous form as disclosed herein, for example. Components that may be included in certain embodiments of a dishwashing detergent composition include, for example, one or more of a phosphate; oxygen- or chlorine-based bleaching agent; non-ionic surfactant; alkaline salt (e.g., metasilicates, alkali metal hydroxides, sodium carbonate); any active enzyme disclosed herein; anti-corrosion agent (e.g., sodium silicate); anti-foaming agent; additives to slow down the removal of glaze and patterns from ceramics; perfume; anti-caking agent (in granular detergent); starch (in tablet-based detergents); gelling agent (in liquid/gel based detergents); and/or sand (powdered detergents).

Dishwashing detergents such as an automatic dishwasher detergent or liquid dishwashing detergent can comprise (i) a non-ionic surfactant, including any ethoxylated non-ionic surfactant, alcohol alkoxylated surfactant, epoxy-capped poly(oxyalkylated) alcohol, or amine oxide surfactant present in an amount from 0 to 10 wt%; (ii) a builder, in the range of about 5-60 wt%, including any phosphate builder (e.g., mono-phosphates, di-phosphates, tri-polyphosphates, other oligomeric-polyphosphates, sodium tripolyphosphate-STPP), any phosphate-free builder (e.g., amino acid-based compounds including methyl-glycine-diacetic acid [MGDA] and salts or derivatives thereof, glutamic-N,N-diacetic acid [GLDA] and salts or derivatives thereof, iminodisuccinic acid (IDS) and salts or derivatives thereof, carboxy methyl inulin and salts or derivatives thereof, nitrilotriacetic acid [NTA], diethylene triamine penta acetic acid [DTPA], B-alaninediacetic acid [B-ADA] and salts thereof), homopolymers and copolymers of poly-carboxylic acids and partially or completely neutralized salts thereof, monomeric polycarboxylic acids and hydroxycarboxylic acids and salts thereof in the range of 0.5 wt% to 50 wt%, or sulfonated/carboxylated polymers in the range of about 0.1 wt% to about 50 wt%; (iii) a drying aid in the range of about 0.1 wt% to about 10 wt% (e.g., polyesters, especially anionic polyesters, optionally together with further monomers with 3 to 6 functionalities – typically acid, alcohol or ester functionalities which are conducive to polycondensation, polycarbonate-, polyurethane- and/or polyurea-polyorganosiloxane compounds or precursor compounds thereof, particularly of the reactive cyclic carbonate and urea type); (iv) a silicate in the range from about 1 wt% to about 20 wt% (e.g., sodium or potassium silicates such as sodium disilicate, sodium meta-silicate and crystalline phyllosilicates); (v) an inorganic bleach (e.g., perhydrate salts such as perborate, percarbonate, perphosphate, persulfate and persilicate salts) and/or an organic bleach (e.g., organic peroxyacids such as diacyl- and tetraacylperoxides, especially diperoxydodecanedioic acid, diperoxytetradecanedioic acid, and diperoxyhexadecanedioic acid); (vi) a bleach activator (e.g., organic peracid precursors in the range from about 0.1 wt% to about 10 wt%) and/or bleach catalyst (e.g., manganese triazacyclononane and related complexes; Co, Cu, Mn, and Fe bispyridylamine and related complexes; and pentamine acetate cobalt(III) and related complexes); (vii) a metal care agent in the range from about 0.1 wt% to 5 wt% (e.g., benzatriazoles, metal salts and complexes, and/or silicates); and/or (viii) any active enzyme disclosed herein in the range from about 0.01 to 5.0 mg of active enzyme per gram of automatic dishwashing detergent composition, and an enzyme stabilizer component (e.g., oligosaccharides, polysaccharides, and inorganic divalent metal salts).

Various examples of detergent formulations comprising at least one soy polysaccharide ether compound herein are disclosed below (1-19):

1) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: linear alkylbenzenesulfonate (calculated as acid) at about 7-12 wt%; alcohol ethoxysulfate (e.g., C12-18 alcohol, 1-2 ethylene oxide [EO]) or alkyl sulfate (e.g., C16-18) at about 1-4 wt%; alcohol ethoxylate (e.g., C14-15 alcohol) at about 5-9 wt%; sodium carbonate at about 14-20 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at about 2-6 wt%; zeolite (e.g., $NaAlSiO_4$) at about 15-22 wt%; sodium sulfate at about 0-6 wt%; sodium citrate/citric acid at about 0-15 wt%; sodium perborate at about 11-18 wt%; TAED at about 2-6 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., maleic/acrylic acid copolymer, PVP, PEG) at about 0-3 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., suds suppressors, perfumes, optical brightener, photobleach) at about 0-5 wt%.

2) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: linear alkylbenzenesulfonate (calculated as acid) at about 6-11 wt%; alcohol ethoxysulfate (e.g., C12-18 alcohol, 1-2 EO) or alkyl sulfate (e.g., C16-18) at about 1-3 wt%; alcohol ethoxylate (e.g., C14-15 alcohol) at about 5-9 wt%; sodium carbonate at about 15-21 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at about 1-4 wt%; zeolite (e.g., $NaAlSiO_4$) at about 24-34 wt%; sodium sulfate at about 4-10 wt%; sodium citrate/citric acid at about 0-15 wt%; sodium perborate at about 11-18 wt%; TAED at about 2-6 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., maleic/acrylic acid copolymer, PVP, PEG) at about 1-6 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%;

and minor ingredients (e.g., suds suppressors, perfumes, optical brightener, photobleach) at about 0-5 wt%.

3) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: linear alkylbenzenesulfonate (calculated as acid) at about 5-9 wt%; alcohol ethoxysulfate (e.g., C12-18 alcohol, 7 EO) at about 7-14 wt%; soap as fatty acid (e.g., C16-22 fatty acid) at about 1-3 wt%; sodium carbonate at about 10-17 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at about 3-9 wt%; zeolite (e.g., $NaAlSiO_4$) at about 23-33 wt%; sodium sulfate at about 0-4 wt%; sodium perborate at about 8-16 wt%; TAED at about 2-8 wt%; phosphonate (e.g., EDTMPA) at about 0-1 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., maleic/acrylic acid copolymer, PVP, PEG) at about 0-3 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., suds suppressors, perfumes, optical brightener) at about 0-5 wt%.

4) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: linear alkylbenzenesulfonate (calculated as acid) at about 8-12 wt%; alcohol ethoxylate (e.g., C12-18 alcohol, 7 EO) at about 10-25 wt%; sodium carbonate at about 14-22 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at about 1-5 wt%; zeolite (e.g., $NaAlSiO_4$) at about 25-35 wt%; sodium sulfate at about 0-10 wt%; sodium perborate at about 8-16 wt%; TAED at about 2-8 wt%; phosphonate (e.g., EDTMPA) at about 0-1 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., maleic/acrylic acid copolymer, PVP, PEG) at about 1-3 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., suds suppressors, perfumes) at about 0-5 wt%.

5) An aqueous liquid detergent composition comprising: linear alkylbenzenesulfonate (calculated as acid) at about 15-21 wt%; alcohol ethoxylate (e.g., C12-18 alcohol, 7 EO; or C12-15 alcohol, 5 EO) at about 12-18 wt%; soap as fatty acid (e.g., oleic acid) at about 3-13 wt%; alkenylsuccinic acid (C12-14) at about 0-13 wt%; aminoethanol at about 8-18 wt%; citric acid at about 2-8 wt%; phosphonate at about 0-3 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., PVP, PEG) at about 0-3 wt%; borate at about 0-2 wt%; ethanol at about 0-3 wt%; propylene glycol at about 8-14 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., dispersants, suds suppressors, perfume, optical brightener) at about 0-5 wt%.

6) An aqueous structured liquid detergent composition comprising: linear alkylbenzenesulfonate (calculated as acid) at about 15-21 wt%; alcohol ethoxylate (e.g., C12-18 alcohol, 7 EO; or C12-15 alcohol, 5 EO) at about 3-9 wt%; soap as fatty acid (e.g., oleic acid) at about 3-10 wt%; zeolite (e.g., $NaAlSiO_4$) at about 14-22 wt%; potassium citrate about 9-18 wt%; borate at about 0-2 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., PVP, PEG) at about 0-3 wt%; ethanol at about 0-3 wt%; anchoring polymers (e.g., lauryl methacrylate/acrylic acid copolymer, molar ratio 25:1, MW 3800) at about 0-3 wt%; glycerol at about 0-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., dispersants, suds suppressors, perfume, optical brightener) at about 0-5 wt%.

7) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: fatty alcohol sulfate at about 5-10 wt%, ethoxylated fatty acid monoethanolamide at about 3-9 wt%; soap as fatty acid at about 0-3 wt%; sodium carbonate at about 5-10 wt%; soluble silicate (e.g., $Na_2O\ 2SiO_2$) at about 1-4 wt%; zeolite (e.g., $NaAlSiO_4$) at about 20-40 wt%; sodium sulfate at about 2-8 wt%; sodium perborate at about 12-18 wt%; TAED at about 2-7 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., maleic/acrylic acid copolymer, PEG) at about 1-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., optical brightener, suds suppressors, perfumes) at about 0-5 wt%.

8) A detergent composition formulated as a granulate comprising: linear alkylbenzenesulfonate (calculated as acid) at about 8-14 wt%; ethoxylated fatty acid monoethanolamide at about 5-11 wt%; soap as fatty acid at about 0-3 wt%; sodium carbonate at about 4-10 wt%; soluble silicate (e.g., $Na_2O\ 2SiO_2$) at about 1-4 wt%; zeolite (e.g., $NaAlSiO_4$) at about 30-50 wt%; sodium sulfate at about 3-11 wt%; sodium citrate at about 5-12 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., PVP, maleic/acrylic acid copolymer, PEG) at about 1-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., suds suppressors, perfumes) at about 0-5 wt%.

9) A detergent composition formulated as a granulate comprising: linear alkylbenzenesulfonate (calculated as acid) at about 6-12 wt%; nonionic surfactant at about 1-4 wt%; soap as fatty acid at about 2-6 wt%; sodium carbonate at about 14-22

wt%; zeolite (e.g., $NaAlSiO_4$) at about 18-32 wt%; sodium sulfate at about 5-20 wt%; sodium citrate at about 3-8 wt%; sodium perborate at about 4-9 wt%; bleach activator (e.g., NOBS or TAED) at about 1-5 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., polycarboxylate or PEG) at about 1-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., optical brightener, perfume) at about 0-5 wt%.

10) An aqueous liquid detergent composition comprising: linear alkylbenzenesulfonate (calculated as acid) at about 15-23 wt%; alcohol ethoxysulfate (e.g., C12-15 alcohol, 2-3 EO) at about 8-15 wt%; alcohol ethoxylate (e.g., C12-15 alcohol, 7 EO; or C12-15 alcohol, 5 EO) at about 3-9 wt%; soap as fatty acid (e.g., lauric acid) at about 0-3 wt%; aminoethanol at about 1-5 wt%; sodium citrate at about 5-10 wt%; hydrotrope (e.g., sodium toluenesulfonate) at about 2-6 wt%; borate at about 0-2 wt%; a soy polysaccharide ether compound herein up to about 1 wt%; ethanol at about 1-3 wt%; propylene glycol at about 2-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., dispersants, perfume, optical brighteners) at about 0-5 wt%.

11) An aqueous liquid detergent composition comprising: linear alkylbenzenesulfonate (calculated as acid) at about 20-32 wt%; alcohol ethoxylate (e.g., C12-15 alcohol, 7 EO; or C12-15 alcohol, 5 EO) at about 6-12 wt%; aminoethanol at about 2-6 wt%; citric acid at about 8-14 wt%; borate at about 1-3 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; ethanol at about 1-3 wt%; propylene glycol at about 2-5 wt%; other polymers (e.g., maleic/acrylic acid copolymer, anchoring polymer such as lauryl methacrylate/acrylic acid copolymer) at about 0-3 wt%; glycerol at about 3-8 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., hydrotropes, dispersants, perfume, optical brighteners) at about 0-5 wt%.

12) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: anionic surfactant (e.g., linear alkylbenzenesulfonate, alkyl sulfate, alpha-olefinsulfonate, alpha-sulfo fatty acid methyl esters, alkanesulfonates, soap) at about 25-40 wt%; nonionic surfactant (e.g., alcohol ethoxylate) at about 1-10 wt%; sodium carbonate at about 8-25 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at about 5-15 wt%; sodium sulfate at about 0-5 wt%; zeolite ($NaAlSiO_4$) at about 15-28 wt%; sodium perborate at about 0-20 wt%; bleach activator (e.g., TAED or NOBS) at about 0-

5 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., perfume, optical brighteners) at about 0-3 wt%.

13) Detergent compositions as described in (1)-(12) above, but in which all or part of the linear alkylbenzenesulfonate is replaced by C12-C18 alkyl sulfate.

14) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: C12-C18 alkyl sulfate at about 9-15 wt%; alcohol ethoxylate at about 3-6 wt%; polyhydroxy alkyl fatty acid amide at about 1-5 wt%; zeolite (e.g., $NaAlSiO_4$) at about 10-20 wt%; layered disilicate (e.g., SK56 from Hoechst) at about 10-20 wt%; sodium carbonate at about 3-12 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at 0-6 wt%; sodium citrate at about 4-8 wt%; sodium percarbonate at about 13-22 wt%; TAED at about 3-8 wt%; a soy polysaccharide ether compound herein up to about 2 wt%; other polymers (e.g., polycarboxylates and PVP) at about 0-5 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., optical brightener, photobleach, perfume, suds suppressors) at about 0-5 wt%.

15) A detergent composition formulated as a granulate having a bulk density of at least 600 g/L comprising: C12-C18 alkyl sulfate at about 4-8 wt%; alcohol ethoxylate at about 11-15 wt%; soap at about 1-4 wt%; zeolite MAP or zeolite A at about 35-45 wt%; sodium carbonate at about 2-8 wt%; soluble silicate (e.g., Na_2O $2SiO_2$) at 0-4 wt%; sodium percarbonate at about 13-22 wt%; TAED at about 1-8 wt%; a soy polysaccharide ether compound herein up to about 3 wt%; other polymers (e.g., polycarboxylates and PVP) at about 0-3 wt%; optionally an enzyme(s) (calculated as pure enzyme protein) at about 0.0001-0.1 wt%; and minor ingredients (e.g., optical brightener, phosphonate, perfume) at about 0-3 wt%.

16) Detergent formulations as described in (1)-(15) above, but that contain a stabilized or encapsulated peracid, either as an additional component or as a substitute for an already specified bleach system(s).

17) Detergent compositions as described in (1), (3), (7), (9) and (12) above, but in which perborate is replaced by percarbonate.

18) Detergent compositions as described in (1), (3), (7), (9), (12), (14) and (15) above, but that additionally contain a manganese catalyst. A manganese catalyst, for example, is one of the compounds described by Hage et al. (1994, *Nature* 369:637-639), which is incorporated herein by reference.

19) Detergent compositions formulated as a non-aqueous detergent liquid comprising a liquid non-ionic surfactant (e.g., a linear alkoxylated primary alcohol), a builder system (e.g., phosphate), a soy polysaccharide ether compound herein, optionally an enzyme(s), and alkali. The detergent may also comprise an anionic surfactant and/or bleach system.

It is believed that numerous commercially available detergent formulations can be adapted to include a soy polysaccharide ether compound disclosed herein. Examples include PUREX® ULTRAPACKS (Henkel), FINISH® QUANTUM (Reckitt Benckiser), CLOROX™ 2 PACKS (Clorox), OXICLEAN MAX FORCE POWER PAKS (Church & Dwight), TIDE® STAIN RELEASE, CASCADE® ACTIONPACS, and TIDE® PODS™ (Procter & Gamble).

Compositions disclosed herein can be in the form of an oral care composition, for example. Examples of oral care compositions include dentifrices, toothpaste, mouth wash, mouth rinse, chewing gum, edible strips, and tooth cream/gel that provide some form of oral care (e.g., treatment or prevention of cavities [dental caries], gingivitis, plaque, tartar, and/or periodontal disease). An oral care composition can also be for treating an “oral surface”, which encompasses any soft or hard surface within the oral cavity including surfaces of the tongue, hard and soft palate, buccal mucosa, gums and dental surfaces. A “dental surface” herein is a surface of a natural tooth or a hard surface of artificial dentition including a crown, cap, filling, bridge, denture, or dental implant, for example.

An oral care composition herein can comprise about 0.01-15.0 wt% (e.g., ~0.1-10 wt% or ~0.1-5.0 wt%, ~0.1-2.0 wt%) of one or more soy polysaccharide ether compounds disclosed herein, for example. One or more soy polysaccharide ether compounds comprised in an oral care composition typically are sometimes provided therein as a thickening agent and/or dispersion agent, which may be useful to impart a desired consistency and/or mouth feel to the composition. One or more other thickening or dispersion agents can also be provided in an oral care composition herein, such as a carboxyvinyl polymer, carrageenan (e.g., L-carrageenan), natural gum (e.g., karaya, xanthan, gum arabic, tragacanth), colloidal magnesium aluminum silicate, or colloidal silica, for example.

An oral care composition herein may be a toothpaste or other dentifrice, for example. Such compositions, as well as any other oral care composition herein, can additionally comprise, without limitation, one or more of an anticaries agent, antimicrobial or antibacterial agent, anticalculus or tartar control agent, surfactant, abrasive, pH-modifying agent, foam modulator, humectant, flavorant, sweetener, pigment/colorant, whitening agent, and/or other suitable components. Examples of oral care compositions to which one or more soy polysaccharide ether compounds can be added are disclosed in U.S. Patent Appl. Publ. Nos. 2006/0134025, 2002/0022006 and 2008/0057007, which are incorporated herein by reference.

An anticaries agent herein can be an orally acceptable source of fluoride ions. Suitable sources of fluoride ions include fluoride, monofluorophosphate and fluorosilicate salts as well as amine fluorides, including olaflur (N'-octadecyltrimethylendiamine-N,N,N'- tris(2-ethanol)-dihydrofluoride), for example. An anticaries agent can be present in an amount providing a total of about 100-20000 ppm, about 200-5000 ppm, or about 500-2500 ppm, fluoride ions to the composition, for example. In oral care compositions in which sodium fluoride is the sole source of fluoride ions, an amount of about 0.01-5.0 wt%, about 0.05-1.0 wt%, or about 0.1-0.5 wt%, sodium fluoride can be present in the composition, for example.

An antimicrobial or antibacterial agent suitable for use in an oral care composition herein includes, for example, phenolic compounds (e.g., 4-allylcatechol; p-hydroxybenzoic acid esters such as benzylparaben, butylparaben, ethylparaben, methylparaben and propylparaben; 2-benzylphenol; butylated hydroxyanisole; butylated hydroxytoluene; capsaicin; carvacrol; creosol; eugenol; guaiacol; halogenated bisphenolics such as hexachlorophene and bromochlorophene; 4-hexylresorcinol; 8-hydroxyquinoline and salts thereof; salicylic acid esters such as menthyl salicylate, methyl salicylate and phenyl salicylate; phenol; pyrocatechol; salicylanilide; thymol; halogenated diphenylether compounds such as triclosan and triclosan monophosphate), copper (II) compounds (e.g., copper (II) chloride, fluoride, sulfate and hydroxide), zinc ion sources (e.g., zinc acetate, citrate, gluconate, glycinate, oxide, and sulfate), phthalic acid and salts thereof (e.g., magnesium monopotassium phthalate), hexetidine, octenidine, sanguinarine, benzalkonium chloride, domiphen bromide, alkylpyridinium chlorides (e.g. cetylpyridinium chloride, tetradecylpyridinium chloride, N-tetradecyl-4-ethylpyridinium chloride), iodine, sulfonamides, bisbiguanides (e.g., alexidine, chlorhexidine, chlorhexidine digluconate), piperidino derivatives (e.g., delmopinol, octapinol), magnolia extract, grapeseed extract, rosemary extract, menthol, geraniol, citral, eucalyptol, antibiotics (e.g., augmentin, amoxicillin, tetracycline, doxycycline, minocycline, metronidazole, neomycin, kanamycin, clindamycin), and/or any antibacterial agents disclosed in U.S. Patent No. 5776435, which is incorporated herein by reference. One or more antimicrobial agents can optionally be present at about 0.01-10 wt% (e.g., 0.1-3 wt%), for example, in the disclosed oral care composition.

An anticalculus or tartar control agent suitable for use in an oral care composition herein includes, for example, phosphates and polyphosphates (e.g., pyrophosphates), polyaminopropanesulfonic acid (AMPS), zinc citrate trihydrate, polypeptides (e.g., polyaspartic and polyglutamic acids), polyolefin sulfonates, polyolefin phosphates, diphosphonates (e.g.,azacycloalkane-2,2-diphosphonates such as azacycloheptane-2,2-diphosphonic acid), N-methyl azacyclopentane-2,3-diphosphonic acid, ethane-1-hydroxy-1,1-diphosphonic acid (EHDP), ethane-1-amino-1,1-diphosphonate, and/or phosphonoalkane carboxylic acids and salts thereof (e.g., their alkali metal and ammonium salts). Useful inorganic phosphate and polyphosphate salts include, for example, monobasic, dibasic and tribasic sodium phosphates, sodium tripolyphosphate, tetrapolyphosphate, mono-, di-, tri- and tetra-sodium pyrophosphates, disodium dihydrogen pyrophosphate, sodium trimetaphosphate, sodium hexametaphosphate, or any of these in which sodium is replaced by potassium or ammonium. Other useful anticalculus agents in certain embodiments include anionic polycarboxylate polymers (e.g., polymers or copolymers of acrylic acid, methacrylic, and maleic anhydride such as polyvinyl methyl ether/maleic anhydride copolymers). Still other useful anticalculus agents include sequestering agents such as hydroxycarboxylic acids (e.g., citric, fumaric, malic, glutaric and oxalic acids and salts thereof) and aminopolycarboxylic acids (e.g., EDTA). One or more anticalculus or tartar control agents can optionally be present at about 0.01-50 wt% (e.g., about 0.05-25 wt% or about 0.1-15 wt%), for example, in the disclosed oral care composition.

A surfactant suitable for use in an oral care composition herein may be anionic, non-ionic, or amphoteric, for example. Suitable anionic surfactants include, without limitation, water-soluble salts of C_{8-20} alkyl sulfates, sulfonated monoglycerides of C_{8-20} fatty acids, sarcosinates, and taurates. Examples of anionic surfactants include sodium lauryl sulfate, sodium coconut monoglyceride sulfonate, sodium lauryl sarcosinate, sodium lauryl isoethionate, sodium laureth carboxylate and sodium dodecyl benzenesulfonate. Suitable non-ionic surfactants include, without limitation, poloxamers, polyoxyethylene sorbitan esters, fatty alcohol ethoxylates, alkylphenol ethoxylates, tertiary amine oxides, tertiary phosphine oxides, and dialkyl sulfoxides. Suitable amphoteric surfactants include, without limitation, derivatives of C_{8-20} aliphatic secondary and tertiary amines having an anionic group such as a carboxylate, sulfate, sulfonate, phosphate or phosphonate. An example of a suitable amphoteric surfactant is cocoamidopropyl betaine. One or more surfactants are optionally present in a total amount of about 0.01-10 wt% (e.g., about 0.05-5.0 wt% or about 0.1-2.0 wt%), for example, in the disclosed oral care composition.

An abrasive suitable for use in an oral care composition herein may include, for example, silica (e.g., silica gel, hydrated silica, precipitated silica), alumina, insoluble phosphates, calcium carbonate, and resinous abrasives (e.g., a urea-formaldehyde condensation product). Examples of insoluble phosphates useful as abrasives herein are orthophosphates, polymetaphosphates and pyrophosphates, and include dicalcium orthophosphate dihydrate, calcium pyrophosphate, beta-calcium pyrophosphate, tricalcium phosphate, calcium polymetaphosphate and insoluble sodium polymetaphosphate. One or more abrasives are optionally present in a total amount of about 5-70 wt% (e.g., about 10-56 wt% or about 15-30 wt%), for example, in the disclosed oral care composition. The average particle size of an abrasive in certain embodiments is about 0.1-30 microns (e.g., about 1-20 microns or about 5-15 microns).

An oral care composition in certain embodiments may comprise at least one pH-modifying agent. Such agents may be selected to acidify, make more basic, or buffer the pH of a composition to a pH range of about 2-10 (e.g., pH ranging from about 2-8, 3-9, 4-8, 5-7, 6-10, or 7-9). Examples of pH-modifying agents useful herein include, without limitation, carboxylic, phosphoric and sulfonic acids; acid salts (e.g., monosodium citrate, disodium citrate, monosodium malate); alkali metal hydroxides (e.g. sodium hydroxide, carbonates such as sodium carbonate, bicarbonates, sesquicarbonates); borates; silicates; phosphates (e.g., monosodium phosphate, trisodium phosphate, pyrophosphate salts); and imidazole.

A foam modulator suitable for use in an oral care composition herein may be a polyethylene glycol (PEG), for example. High molecular weight PEGs are suitable, including those having an average molecular weight of about 200000-7000000 (e.g., about 500000-5000000 or about 1000000-2500000), for example. One or more PEGs are optionally present in a total amount of about 0.1-10 wt% (e.g. about 0.2-5.0 wt% or about 0.25-2.0 wt%), for example, in the disclosed oral care composition.

An oral care composition in certain embodiments may comprise at least one humectant. A humectant in certain embodiments may be a polyhydric alcohol such as glycerin, sorbitol, xylitol, or a low molecular weight PEG. Most suitable humectants also may function as a sweetener herein. One or more humectants are optionally present in a total amount of about 1.0-70 wt% (e.g., about 1.0-50 wt%, about 2-25 wt%, or about 5-15 wt%), for example, in the disclosed oral care composition.

A natural or artificial sweetener may optionally be comprised in an oral care composition herein. Examples of suitable sweeteners include dextrose, sucrose, maltose, dextrin, invert sugar, mannose, xylose, ribose, fructose, levulose, galactose, corn syrup (e.g., high fructose corn syrup or corn syrup solids), partially hydrolyzed starch, hydrogenated starch hydrolysate, sorbitol, mannitol, xylitol, maltitol, isomalt, aspartame, neotame, saccharin and salts thereof, dipeptide-based intense sweeteners, and cyclamates. One or more sweeteners are optionally present in a total amount of about 0.005-5.0 wt%, for example, in the disclosed oral care composition.

A natural or artificial flavorant may optionally be comprised in an oral care composition herein. Examples of suitable flavorants include vanillin; sage; marjoram; parsley oil; spearmint oil; cinnamon oil; oil of wintergreen (methylsalicylate); peppermint oil; clove oil; bay oil; anise oil; eucalyptus oil; citrus oils; fruit oils; essences such as those derived from lemon, orange, lime, grapefruit, apricot, banana, grape, apple, strawberry, cherry, or pineapple; bean- and nut-derived flavors such as coffee, cocoa, cola, peanut, or almond; and adsorbed and encapsulated flavorants. Also encompassed within flavorants herein are ingredients that provide fragrance and/or other sensory effect in the mouth, including cooling or warming effects. Such ingredients include, without limitation, menthol, menthyl acetate, menthyl lactate, camphor, eucalyptus oil, eucalyptol, anethole, eugenol, cassia, oxanone, Irisone®, propenyl guaiethol, thymol, linalool, benzaldehyde, cinnamaldehyde, N-ethyl-p-menthan-3-carboxamine, N,2,3-trimethyl-2-isopropylbutanamide, 3-(1-menthoxy)-propane-1,2-diol, cinnamaldehyde glycerol acetal (CGA), and menthone glycerol acetal (MGA). One or more flavorants are optionally present in a total amount of about 0.01-5.0 wt% (e.g., about 0.1-2.5 wt%), for example, in the disclosed oral care composition.

An oral care composition in certain embodiments may comprise at least one bicarbonate salt. Any orally acceptable bicarbonate can be used, including alkali metal bicarbonates such as sodium or potassium bicarbonate, and ammonium bicarbonate, for example. One or more bicarbonate salts are optionally present in a total amount of about 0.1-50 wt% (e.g., about 1-20 wt%), for example, in the disclosed oral care composition.

An oral care composition in certain embodiments may comprise at least one whitening agent and/or colorant. A suitable whitening agent is a peroxide compound such as any of those disclosed in U.S. Patent No. 8540971, which is incorporated herein by reference. Suitable colorants herein include pigments, dyes, lakes and agents imparting a particular luster or reflectivity such as pearling agents, for example. Specific examples of colorants useful herein include talc; mica; magnesium carbonate; calcium carbonate; magnesium silicate; magnesium aluminum silicate; silica; titanium dioxide; zinc oxide; red, yellow, brown and black iron oxides; ferric ammonium ferrocyanide; manganese violet; ultramarine; titaniated mica; and bismuth oxychloride. One or more colorants are optionally present in a total amount of about 0.001-20 wt% (e.g., about 0.01-10 wt% or about 0.1-5.0 wt%), for example, in the disclosed oral care composition.

Additional components that can optionally be included in an oral composition herein include one or more enzymes (above), vitamins, and anti-adhesion agents, for example. Examples of vitamins useful herein include vitamin C, vitamin E, vitamin B5, and folic acid. Examples of suitable anti-adhesion agents include solbrol, ficin, and quorum-sensing inhibitors.

The present disclosure also concerns a method for increasing the viscosity of an aqueous composition. This method comprises contacting a soy polysaccharide ether compound with the aqueous composition, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0. The contacting step in this method results in increasing the viscosity of the aqueous composition, in comparison to the viscosity of the aqueous composition before the contacting step. Any hydrocolloid and aqueous solution disclosed herein, for example, can be produced or modified using this method.

An aqueous composition herein can be water (e.g., de-ionized water), an aqueous solution, or a hydrocolloid, for example. The viscosity of an aqueous composition before the contacting step, measured at about 20-25 °C, can be about 0-10000 cPs (or any integer between 0-10000 cPs), for example. Since the aqueous composition can be a hydrocolloid or the like in certain embodiments, it should be apparent that the method can be used to increase the viscosity of aqueous compositions that are already viscous.

Contacting a soy polysaccharide ether compound herein with an aqueous composition increases the viscosity of the aqueous composition in certain embodiments. This increase in viscosity can be an increase of at least about 1%, 10%, 100%, 1000%, 100000%, or 1000000% (or any integer between 1% and 1000000%), for example, compared to the viscosity of the aqueous composition before the contacting step. It should be apparent that very large percent increases in viscosity can be obtained with the disclosed method when the aqueous composition has little to no viscosity before the contacting step. An increase in viscosity can be determined, for example, by comparing the viscosity of the aqueous composition obtained by the method (i.e., after the contacting step) with the viscosity of the aqueous composition as it had existed before the method (i.e., before the contacting step).

Contacting a soy polysaccharide ether compound herein with an aqueous composition increases the shear thinning behavior or the shear thickening behavior of the aqueous composition in certain embodiments. Thus, a soy polysaccharide ether compound rheologically modifies the aqueous composition in these embodiments. The increase in shear thinning or shear thickening behavior can be an increase of at least about 1%, 10%, 100%, 1000%, 100000%, or 1000000% (or any integer between 1% and 1000000%), for example, compared to the shear thinning or shear thickening behavior of the aqueous composition before the contacting step. It should be apparent that very large percent increases in rheologic modification can be obtained with the disclosed method when the aqueous composition has little to no rheologic behavior before the contacting step.

The contacting step in a method for increasing the viscosity of an aqueous composition can be performed by mixing or dissolving any presently disclosed soy polysaccharide ether compound in the aqueous composition by any means known in the art. For example, mixing or dissolving can be performed manually or with a machine (e.g., industrial mixer or blender, orbital shaker, stir plate, homogenizer, sonicator, bead mill). Mixing or dissolving can comprise a homogenization step in certain embodiments.

Homogenization (as well as any other type of mixing) can be performed for about 5 to 60, 5 to 30, 10 to 60, 10 to 30, 5 to 15, or 10 to 15 seconds (or any integer between 5 and 60 seconds), or longer periods of time as necessary to mix soy polysaccharide ether with the aqueous composition. A homogenizer can be used at about 5000 to 30000 rpm, 10000 to 30000 rpm, 15000 to 30000 rpm, 15000 to 25000 rpm, or 20000 rpm (or any integer between 5000 and 30000 rpm), for example.

After a soy polysaccharide ether compound herein is mixed with or dissolved into an aqueous composition, the resulting aqueous composition may be filtered, or may not be filtered. For example, an aqueous composition prepared with a homogenization step may or may not be filtered.

Certain embodiments of the above method can be used to prepare an aqueous composition disclosed herein, such as a food product (e.g., a confectionery such as a candy filling), pharmaceutical product (e.g., excipient), household product (e.g., laundry detergent, fabric softener, dishwasher detergent), personal care product (e.g., a water-containing dentifrice such as toothpaste), or industrial product.

The present disclosure also concerns a method of treating a material. This method comprises contacting a material with an aqueous composition comprising at least one soy polysaccharide ether compound, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.

A material contacted with an aqueous composition in a contacting method herein can comprise a fabric in certain embodiments. A fabric herein can comprise natural fibers, synthetic fibers, semi-synthetic fibers, or any combination thereof. A semi-synthetic fiber herein is produced using naturally occurring material that has been chemically derivatized, an example of which is rayon. Non-limiting examples of fabric types herein include fabrics made of (i) cellulosic fibers such as cotton (e.g., broadcloth, canvas, chambray, chenille, chintz, corduroy, cretonne, damask, denim, flannel, gingham, jacquard, knit, matelassé, oxford, percale, poplin, plissé, sateen, seersucker, sheers, terry cloth, twill, velvet), rayon (e.g., viscose, modal, lyocell), linen, and Tencel®; (ii) proteinaceous fibers such as silk, wool and related mammalian fibers; (iii) synthetic fibers such as polyester, acrylic, nylon, and the like; (iv) long vegetable fibers from jute, flax, ramie, coir, kapok, sisal, henequen, abaca, hemp and sunn; and (v) any combination of a fabric of (i)-(iv). Fabric comprising a combination of fiber types (e.g., natural and synthetic) include those with both a cotton fiber and polyester, for example. Materials/articles containing one or more fabrics herein include, for example, clothing, curtains, drapes, upholstery, carpeting, bed linens, bath linens, tablecloths, sleeping bags, tents, car interiors, etc. Other materials comprising natural and/or synthetic fibers include, for example, non-woven fabrics, paddings, paper, and foams.

An aqueous composition that is contacted with a fabric can be, for example, a fabric care composition (e.g., laundry detergent, fabric softener). Thus, a treatment method in certain embodiments can be considered a fabric care method or laundry method if employing a fabric care composition therein. A fabric care composition herein is contemplated to effect one or more of the following fabric care benefits (i.e., surface substantive effects): wrinkle removal, wrinkle reduction, wrinkle resistance, fabric wear reduction, fabric wear resistance, fabric pilling reduction, extended fabric life, fabric color maintenance, fabric color fading reduction, reduced dye transfer, fabric color restoration, fabric soiling reduction, fabric soil release, fabric shape retention, fabric smoothness enhancement, anti-redeposition of soil on fabric, anti-greying of laundry, improved fabric hand/handle, and/or fabric shrinkage reduction.

Examples of conditions (e.g., time, temperature, wash/rinse volumes) for conducting a fabric care method or laundry method herein are disclosed in WO1997/003161 and U.S. Patent Nos. 4794661, 4580421 and 5945394, which are incorporated herein by reference. In other examples, a material comprising fabric can be contacted with an aqueous composition herein: (i) for at least about 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, or 120 minutes; (ii) at a temperature of at least about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, or 95 °C (e.g., for laundry wash or rinse: a “cold” temperature of about 15-30 °C, a “warm” temperature of about 30-50 °C, a “hot” temperature of about 50-95 °C); (iii) at a pH of about 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 (e.g., pH range of about 2-12, or about 3-11); (iv) at a salt (e.g., NaCl) concentration of at least about 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, or 4.0 wt%; or any combination of (i)-(iv).

The contacting step in a fabric care method or laundry method can comprise any of washing, soaking, and/or rinsing steps, for example. Contacting a material or fabric in still further embodiments can be performed by any means known in the art, such as dissolving, mixing, shaking, spraying, treating, immersing, flushing, pouring on or in, combining, painting, coating, applying, affixing to, and/or communicating an effective amount of a soy polysaccharide ether compound herein with the fabric or material. In still further embodiments, contacting may be used to treat a fabric to provide a surface substantive effect. As used herein, the term “fabric hand” or “handle” refers to a person’s tactile sensory response towards fabric which may be physical, physiological, psychological, social or any combination thereof. In one embodiment, the fabric hand may be measured using a PhabrOmeter® System for measuring relative hand value (available from Nu Cybertek, Inc. Davis, CA) (American Association of Textile Chemists and Colorists (AATCC test method “202-2012, Relative Hand Value of Textiles: Instrumental Method”)).

In certain embodiments of treating a material comprising fabric, a soy polysaccharide ether component(s) of the aqueous composition adsorbs to the fabric. This feature is believed to render soy polysaccharide ether compounds herein useful as anti-redeposition agents and/or anti-greying agents in fabric care compositions (in addition to their viscosity-modifying effect). An anti-redeposition agent or anti-greying agent herein helps keep soil from redepositing onto clothing in wash water after the soil has been removed. It is further contemplated that adsorption of one or more soy polysaccharide ether compounds herein to a fabric enhances mechanical properties of the fabric.

Adsorption of a soy polysaccharide ether compound to a fabric herein can be measured using a colorimetric technique (e.g., Dubois et al., 1956, *Anal. Chem.* 28:350-356; Zemljič et al., 2006, *Lenzinger Berichte* 85:68-76; both incorporated herein by reference), for example, or any other method known in the art.

Other materials that can be contacted in the above treatment method include surfaces that can be treated with a dish detergent (e.g., automatic dishwashing detergent or hand dish detergent). Examples of such materials include surfaces of dishes, glasses, pots, pans, baking dishes, utensils and flatware made from ceramic material, china, metal, glass, plastic (e.g., polyethylene, polypropylene, polystyrene, etc.) and wood (collectively referred to herein as “tableware”). Thus, the treatment method in certain embodiments can be considered a dishwashing method or tableware washing method, for example. Examples of conditions (e.g., time, temperature, wash volume) for conducting a dishwashing or tableware washing method herein are disclosed in U.S. Patent No. 8575083, which is incorporated herein by reference. In other examples, a tableware article can be contacted with an aqueous composition herein under a suitable set of conditions such as any of those disclosed above with regard to contacting a fabric-comprising material.

Other materials that can be contacted in the above treatment method include oral surfaces such as any soft or hard surface within the oral cavity including surfaces of the tongue, hard and soft palate, buccal mucosa, gums and dental surfaces (e.g., natural tooth or a hard surface of artificial dentition such as a crown, cap, filling, bridge, denture, or dental implant). Thus, a treatment method in certain embodiments can be considered an oral care method or dental care method, for example. Conditions (e.g., time, temperature) for contacting an oral surface with an aqueous composition herein should be suitable for the intended purpose of making such contact. Other surfaces that can be contacted in a treatment method also include a surface of the integumentary system such as skin, hair or nails.

Thus, certain embodiments of the disclosure concern material (e.g., fabric) that comprises a soy polysaccharide ether compound herein. Such material can be produced following a material treatment method as disclosed herein, for example. A material may comprise a soy polysaccharide ether compound in certain embodiments if the compound is adsorbed to, or otherwise in contact with, the surface of the material.

Certain embodiments of a method of treating a material herein further comprise a drying step, in which a material is dried after being contacted with the aqueous composition. A drying step can be performed directly after the contacting step, or following one or more additional steps that might follow the contacting step (e.g., drying of a fabric after being rinsed, in water for example, following a wash in an aqueous composition herein). Drying can be performed by any of several means known in the art, such as air drying (e.g., ~20-25 °C), or at a temperature of at least about 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 170, 175, 180, or 200 °C, for example. A material that has been dried herein typically has less than 3, 2, 1, 0.5, or 0.1 wt% water comprised therein. Fabric is a preferred material for conducting an optional drying step.

An aqueous composition used in a treatment method herein can be any aqueous composition disclosed herein, such as in the above embodiments or in the below Examples. Thus, the soy polysaccharide ether component(s) of an aqueous composition can be any as disclosed herein. Examples of aqueous compositions include detergents (e.g., laundry detergent or dish detergent) and water-containing dentifrices such as toothpaste.

The present disclosure also concerns a method for producing a soy polysaccharide ether compound. This method comprises: contacting soy polysaccharide in a reaction under alkaline conditions with at least one etherification agent comprising an organic group, wherein at least one organic group is etherified to the soy polysaccharide thereby producing a soy polysaccharide ether compound. A soy polysaccharide ether compound produced in this manner has a degree of substitution with the organic group of about 0.0025 to about 3.0, and can optionally be isolated. This method can be considered to comprise an etherification reaction.

The following steps can be taken to prepare the above etherification reaction in some embodiments. Soy polysaccharide is contacted in a reaction under alkaline conditions with at least one etherification agent comprising an organic group. This step can be performed, for example, by first preparing alkaline conditions by contacting soy polysaccharide with a solvent (e.g., water or alcohol) and one or more alkali hydroxides to provide a preparation (e.g., a mixture such as a slurry, where soy polysaccharide is mixed in an alkali hydroxide solution) (e.g., a solution if using an appropriate solvent – see below). The alkaline conditions of the etherification reaction can thus comprise an alkali hydroxide solution in some aspects. The pH of the alkaline conditions can be at least about 11.0, 11.2, 11.4, 11.6, 11.8, 12.0, 12.2, 12.4, 12.6, 12.8, or 13.0, for example.

Various alkali hydroxides can be used, such as sodium hydroxide, potassium hydroxide, calcium hydroxide, lithium hydroxide, and/or tetraethylammonium hydroxide. The concentration of alkali hydroxide in a preparation with soy polysaccharide and a solvent can be from about 1-54 wt%, 5-50 wt%, 5-10 wt%, 10-50 wt%, 10-40 wt%, or 10-30 wt% (or any integer between 1 and 54 wt%). Alternatively, the concentration of alkali hydroxide such as sodium hydroxide can be about, or at least about, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 wt%. An alkali hydroxide used to prepare alkaline conditions may be in a completely aqueous solution or an aqueous solution comprising one or more water-soluble organic solvents such as ethanol or isopropanol. Alternatively, an alkali hydroxide can be added as a solid, if desired, to provide alkaline conditions.

Various organic solvents that can optionally be included or used as the main solvent when preparing the etherification reaction include alcohols, acetone, dioxane, isopropanol and toluene, for example; none of these solvents dissolve soy polysaccharide. Toluene or isopropanol can be used in certain embodiments. An organic solvent can be added before or after addition of alkali hydroxide. The concentration of an organic solvent (e.g., isopropanol or toluene) in a preparation comprising soy polysaccharide and an alkali hydroxide can be at least about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, or 90 wt% (or any integer between 10 and 90 wt%).

Alternatively, it is contemplated that the following solvents could be useful for dissolving soy polysaccharide in preparing an etherification reaction. These solvents include, but are not limited to, lithium chloride(LiCl)/N,N-dimethyl-acetamide (DMAc), SO_2/diethylamine (DEA)/dimethyl sulfoxide (DMSO), LiCl/1,3-dimethy-2-imidazolidinone (DMI), N,N-dimethylformamide (DMF)/N_2O_4, DMSO/tetrabutyl-ammonium fluoride trihydrate (TBAF), N-methylmorpholine-N-oxide (NMMO), Ni(tren)$(OH)_2$ [tren¼tris(2-aminoethyl)amine] aqueous solutions, and melts of $LiClO_4 \cdot 3H_2O$, NaOH/urea aqueous solutions.

Soy polysaccharide can be contacted with a solvent and one or more alkali hydroxides by mixing. Such mixing can be performed during or after adding these components with each other. Mixing can be performed by manual mixing, mixing using an overhead mixer, using a magnetic stir bar, or shaking, for example. In certain embodiments, soy polysaccharide can first be mixed in water or an aqueous solution before it is mixed with another solvent and/or alkali hydroxide.

After contacting soy polysaccharide, solvent, and one or more alkali hydroxides with each other, the resulting composition can optionally be maintained at ambient temperature for up to 14 days. The term “ambient temperature” as used herein refers to a temperature between about 15-30 °C or 20-25 °C (or any integer between 15 and 30 °C). Alternatively, the composition can be heated with or without reflux at a temperature from about 30 °C to about 150 °C (or any integer between 30 and 150 °C) for up to about 48 hours. The composition in certain embodiments can be heated at about 55 or 70 °C for about 30-60 minutes. Thus, a composition obtained from mixing soy polysaccharide, solvent, and one or more alkali hydroxides with each other can be heated at about 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, or 75 °C for about 30-90 minutes, for example.

After contacting soy polysaccharide, solvent, and one or more alkali hydroxides with each other, the resulting composition can optionally be filtered (with or without applying a temperature treatment step). Such filtration can be performed using a funnel, centrifuge, press filter, or any other method and/or equipment known in the art that allows removal of liquids from solids. Though filtration would remove much of the alkali hydroxide, the filtered soy polysaccharide would remain alkaline (i.e., mercerized soy polysaccharide), thereby providing alkaline conditions.

An etherification agent comprising an organic group can be contacted with soy polysaccharide in a reaction under alkaline conditions in a method herein of producing soy polysaccharide ether compounds. For example, an etherification agent can be added to a composition prepared by contacting soy polysaccharide, solvent, and one or more alkali hydroxides with each other as described above. Alternatively, an etherification agent can be included when preparing the alkaline conditions (e.g., an etherification agent can be mixed with soy polysaccharide and solvent before mixing with alkali hydroxide). One or more etherification agents may be used in an etherification reaction.

An etherification agent in certain embodiments can be used to etherify an alkyl group, hydroxy alkyl group, or carboxy alkyl group to soy polysaccharide.

Etherification agents suitable for preparing an alkyl soy polysaccharide ether compound include, for example, dialkyl sulfates, dialkyl carbonates, alkyl halides (e.g., alkyl chloride), iodoalkanes, alkyl triflates (alkyl trifluoromethanesulfonates) and alkyl fluorosulfonates. Thus, examples of etherification agents for producing methyl soy polysaccharide ethers include dimethyl sulfate, dimethyl carbonate, methyl chloride, iodomethane, methyl triflate and methyl fluorosulfonate. Examples of etherification agents for producing ethyl soy polysaccharide ethers include diethyl sulfate, diethyl carbonate, ethyl chloride, iodoethane, ethyl triflate and ethyl fluorosulfonate. Examples of etherification agents for producing propyl soy polysaccharide ethers include dipropyl sulfate, dipropyl carbonate, propyl chloride, iodopropane, propyl triflate and propyl fluorosulfonate. Examples of etherification agents for producing butyl soy polysaccharide ethers include dibutyl sulfate, dibutyl carbonate, butyl chloride, iodobutane and butyl triflate.

Etherification agents suitable for preparing a hydroxyalkyl soy polysaccharide ether compound include, for example, alkylene oxides such as ethylene oxide, propylene oxide (e.g., 1,2-propylene oxide), butylene oxide (e.g., 1,2-butylene oxide; 2,3-butylene oxide; 1,4-butylene oxide), or combinations thereof. As examples, propylene oxide can be used as an etherification agent for preparing hydroxypropyl soy polysaccharide, and ethylene oxide can be used as an etherification agent for preparing hydroxyethyl soy polysaccharide. Alternatively, hydroxyalkyl halides (e.g., hydroxyalkyl chloride) can be used as etherification agents for preparing hydroxyalkyl soy polysaccharide. Examples of hydroxyalkyl halides include hydroxyethyl halide, hydroxypropyl halide (e.g., 2-hydroxypropyl chloride, 3-hydroxypropyl chloride) and hydroxybutyl halide. Alternatively, alkylene chlorohydrins can be used as etherification agents for preparing hydroxyalkyl soy polysaccharide. Alkylene chlorohydrins that can be used include, but are not limited to, ethylene chlorohydrin, propylene chlorohydrin, butylene chlorohydrin, or combinations of these.

Etherification agents suitable for preparing a dihydroxyalkyl soy polysaccharide ether compound include dihydroxyalkyl halides (e.g., dihydroxyalkyl chloride) such as dihydroxyethyl halide, dihydroxypropyl halide (e.g., 2,3-dihydroxypropyl chloride [i.e., 3-chloro-1,2-propanediol]), or dihydroxybutyl halide, for example. 2,3-dihydroxypropyl chloride can be used to prepare dihydroxypropyl soy polysaccharide, for example.

Etherification agents suitable for preparing a carboxyalkyl soy polysaccharide ether compound may include haloalkylates (e.g., chloroalkylate). Examples of haloalkylates include haloacetate (e.g., chloroacetate), 3-halopropionate (e.g., 3-chloropropionate) and 4-halobutyrate (e.g., 4-chlorobutyrate). For example, chloroacetate (monochloroacetate) (e.g., sodium chloroacetate or chloroacetic acid) can be used as an etherification agent to prepare carboxymethyl soy polysaccharide.

An etherification agent herein can alternatively be used to etherify a positively charged organic group to soy polysaccharide. Examples of such etherification agents include dialkyl sulfates, dialkyl carbonates, alkyl halides (e.g., alkyl chloride), iodoalkanes, alkyl triflates (alkyl trifluoromethanesulfonates) and alkyl fluorosulfonates, where the alkyl group(s) of each of these agents has one or more substitutions with a positively charged group (e.g., substituted ammonium group such as trimethylammonium). Other examples of such etherification agents include dimethyl sulfate, dimethyl carbonate, methyl chloride, iodomethane, methyl triflate and methyl fluorosulfonate, where the methyl group(s) of each of these agents has a substitution with a positively charged group (e.g., substituted ammonium group such as trimethylammonium). Other examples of such etherification agents include diethyl sulfate, diethyl carbonate, ethyl chloride, iodoethane, ethyl triflate and ethyl fluorosulfonate, where the ethyl group(s) of each of these agents has a substitution with a positively charged group (e.g., substituted ammonium group such as trimethylammonium). Other examples of such etherification agents include dipropyl sulfate, dipropyl carbonate, propyl chloride, iodopropane, propyl triflate and propyl fluorosulfonate, where the propyl group(s) of each of these agents has one or more substitutions with a positively charged group (e.g., substituted ammonium group such as trimethylammonium). Other examples of such etherification agents include dibutyl sulfate, dibutyl carbonate, butyl chloride, iodobutane and butyl triflate, where the butyl group(s) of each of these agents has one or more substitutions with a positively charged group (e.g., substituted ammonium group such as trimethylammonium).

An etherification agent may be one that can etherify soy polysaccharide with a positively charged organic group, where the carbon chain of the positively charged organic group has a substitution (e.g., hydroxyl group) in addition to a substitution with a positively charged group (e.g., substituted ammonium group such as trimethylammonium). Examples of such etherification agents include hydroxyalkyl halides (e.g., hydroxyalkyl chloride) such as hydroxypropyl halide and hydroxybutyl halide, where a terminal carbon of each of these agents has a substitution with a positively charged group (e.g., substituted ammonium group such as trimethylammonium); an example is 3-chloro-2-hydroxypropyl-trimethylammonium. Other examples of such etherification agents include alkylene oxides such as propylene oxide (e.g., 1,2-propylene oxide) and butylene oxide (e.g., 1,2-butylene oxide; 2,3-butylene oxide), where a terminal carbon of each of these agents has a substitution with a positively charged group (e.g., substituted ammonium group such as trimethylammonium).

A substituted ammonium group comprised in any of the foregoing etherification agent examples can be a primary, secondary, tertiary, or quaternary ammonium group. Examples of secondary, tertiary and quaternary ammonium groups are represented in structure I, where R_2, R_3 and R_4 each independently represent a hydrogen atom or an alkyl group such as a methyl, ethyl, propyl, or butyl group.

Etherification agents herein typically can be provided as a fluoride, chloride, bromide, or iodide salt (where each of the foregoing halides serve as an anion).

When producing a soy polysaccharide ether compound with two or more different organic groups, two or more different etherification agents would be used, accordingly. For example, both an alkylene oxide and an alkyl chloride could be used as etherification agents to produce an alkyl hydroxyalkyl soy polysaccharide ether. Any of the etherification agents disclosed herein may be combined to produce soy polysaccharide ether compounds with two or more different organic groups. Such two or more etherification agents may be used in the reaction at the same time, or may be used sequentially in the reaction. When used sequentially, any of the temperature-treatment (e.g., heating) steps disclosed below may optionally be used between each addition. One may choose sequential introduction of etherification agents in order to control the desired DoS of each organic group. In general, a particular etherification agent would be used first if the organic group it forms in the ether product is desired at a higher DoS compared to the DoS of another organic group to be added.

The amount of etherification agent to be contacted with soy polysaccharide in a reaction under alkaline conditions can be determined based on the degree of substitution (DoS) required in the soy polysaccharide ether compound being produced. The amount of ether substitution groups on each monomeric unit of the soy polysaccharide component of an ether compound produced herein can be determined using nuclear magnetic resonance (NMR) spectroscopy. The molar substitution (MS) value for soy polysaccharide has no upper limit. In general, an etherification agent can be used in a quantity of at least about 0.05 mole per mole of soy polysaccharide. There is no upper limit to the quantity of etherification agent that can be used.

Reactions for producing soy polysaccharide ether compounds herein can optionally be carried out in a pressure vessel such as a Parr reactor, an autoclave, a shaker tube or any other pressure vessel well known in the art.

A reaction herein can optionally be heated following the step of contacting soy polysaccharide with an etherification agent under alkaline conditions. The reaction temperatures and time of applying such temperatures can be varied within wide limits. For example, a reaction can optionally be maintained at ambient temperature for up to 14 days. Alternatively, a reaction can be heated, with or without reflux, between about

25 °C to about 200 °C (or any integer between 25 and 200 °C). Reaction time can be varied correspondingly: more time at a low temperature and less time at a high temperature.

In certain embodiments of producing a soy polysaccharide ether (e.g., dihydroxypropyl soy polysaccharide), a reaction can be heated to about 70 °C for about 3-4 hours. Thus, a reaction for preparing a soy polysaccharide ether compound herein can be heated to about 60-80 °C (or any integer between 60 and 80 °C) for about 2 hours to about 5 hours, for example. Etherification agents such as a haloalkylate (e.g., a chloroalkylate such as 3-chloro-1,2-propanediol) can be used in these embodiments, for example.

In certain embodiments of producing quaternary ammonium soy polysaccharide ether (e.g., trimethylammonium hydroxypropyl soy polysaccharide), a reaction can be heated to about 55 °C for about 2.5 hours. Thus, a reaction for preparing a quaternary ammonium soy polysaccharide ether such as trimethylammonium hydroxypropyl soy polysaccharide can optionally be heated to about 50-60 °C for about 2-3 hours, for example. Such a reaction may comprise 3-chloro-2-hydroxypropyl-trimethylammonium as an etherification agent, for example.

Optionally, an etherification reaction herein can be maintained under an inert gas, with or without heating. As used herein, the term “inert gas” refers to a gas which does not undergo chemical reactions under a set of given conditions, such as those disclosed for preparing a reaction herein.

All of the components of the reactions disclosed herein can be mixed together at the same time and brought to the desired reaction temperature, whereupon the temperature is maintained with or without stirring until the desired soy polysaccharide ether compound is formed. Alternatively, the mixed components can be left at ambient temperature as described above. The collective processes herein for preparing an etherification reaction can optionally be characterized as providing an etherification reaction.

Following etherification, the pH of a reaction can be neutralized. Neutralization of a reaction can be performed using one or more acids. The term “neutral pH” as used herein, refers to a pH that is neither substantially acidic or basic (e.g., a pH of about 6-8, or about 6.0, 6.2, 6.4, 6.6, 6.8, 7.0, 7.2, 7.4, 7.6, 7.8, or 8.0). Various acids that can be used for this purpose include, but are not limited to, sulfuric, acetic (e.g., glacial acetic), hydrochloric, nitric, any mineral (inorganic) acid, any organic acid, or any combination of these acids.

A soy polysaccharide ether compound produced in a reaction herein can optionally be washed one or more times with a liquid that does not readily dissolve the compound. For example, soy polysaccharide ether can typically be washed with alcohol (e.g., methanol, ethanol, propanol), acetone, aromatics, or any combination of these, depending on the solubility of the ether compound therein (where lack of solubility is desirable for washing). In general, a solvent comprising an organic solvent such as alcohol is preferred for washing a soy polysaccharide ether. A soy polysaccharide ether product can be washed one or more times with an aqueous solution containing methanol or ethanol, for example. For example, 70-95 wt% ethanol can be used to wash the product. A soy polysaccharide ether product can be washed with a methanol:acetone (e.g., 60:40) solution in another embodiment.

A soy polysaccharide ether produced in the disclosed reaction can optionally be isolated. This step can be performed before or after neutralization and/or washing steps using a funnel, centrifuge, press filter, or any other method or equipment known in the art that allows removal of liquids from solids. An isolated soy polysaccharide ether product can be dried using any method known in the art, such as vacuum drying, air drying, or freeze drying.

Any of the above etherification reactions can be repeated using a soy polysaccharide ether product as the starting material for further modification. This approach may be suitable for increasing the DoS of an organic group, and/or adding one or more different organic groups to the ether product. For example, this approach may be suitable for adding one or more organic groups that are not positively charged, such as an alkyl group (e.g., methyl, ethyl, propyl, butyl) and/or a hydroxyalkyl group (e.g., hydroxyethyl, hydroxypropyl, hydroxybutyl), to a cationic soy polysaccharide ether.

The structure, molecular weight and DoS of a soy polysaccharide ether product can be confirmed using various physiochemical analyses known in the art such as NMR spectroscopy and size exclusion chromatography (SEC).

Any of the embodiments of soy polysaccharide disclosed herein can be used in an etherification reaction, for example. Soy polysaccharide can be provided in some aspects in the form of powder, meal, flakes, or any other suitable form for preparing an etherification reaction. Also, soy polysaccharide can be provided in the form of a soy polysaccharide preparation as disclosed herein.

Non-limiting examples of compositions and methods disclosed herein include:

1. A composition comprising a soy polysaccharide ether compound, wherein the compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.
2. The composition of embodiment 1, wherein the degree of substitution is less than 1.80.
3. The composition of embodiment 1 or 2, wherein the soy polysaccharide is derived from cultivated soybeans.
4. The composition of embodiment 1, 2, or 3, wherein at least one organic group is an alkyl, hydroxy alkyl, or carboxy alkyl group.
5. The composition of embodiment 4, wherein at least one organic group is a methyl, ethyl, hydroxypropyl, dihydroxypropyl, hydroxyethyl, or carboxymethyl group.
6. The composition of embodiment 1, 2, or 3, wherein at least one organic group is a positively charged organic group.
7. The composition of embodiment 6, wherein at least one positively charged organic group comprises a substituted ammonium group.
8. The composition of embodiment 7, wherein the substituted ammonium group is a trimethylammonium group.
9. The composition of embodiment 7, wherein at least one positively charged organic group is a quaternary ammonium hydroxypropyl group.
10. The composition of embodiment 1, 2, 3, 4, 5, 6, 7, 8, or 9, wherein the compound contains one type of organic group.
11. The composition of embodiment 1, 2, 3, 4, 5, 6, 7, 8, or 9, wherein the compound contains two or more types of organic group.
12. The composition of embodiment 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11, wherein the composition is an aqueous composition having a viscosity of at least about 3 cPs.
13. The composition of embodiment 12 or 15, wherein the aqueous composition is in the form of a personal care product, pharmaceutical product, food product, household product, or industrial product.

14. The composition of embodiment 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11, wherein the compound is crosslinked.
15. The composition of embodiment 14, wherein the composition is an aqueous composition having a viscosity of at least about 50 cPs.
16. A method of producing a soy polysaccharide ether compound, the method comprising:
    (a) contacting soy polysaccharide in a reaction under alkaline conditions with at least one etherification agent comprising an organic group, wherein at least one organic group is etherified to the soy polysaccharide thereby producing a soy polysaccharide ether compound, wherein the compound has a degree of substitution with the at least one organic group of about 0.0025 to about 3.0; and
    (b) optionally, isolating the soy polysaccharide ether compound produced in step (a).
17. A method for increasing the viscosity of an aqueous composition, the method comprising:
    contacting a soy polysaccharide ether compound according to any one of embodiments 1-11 and 14 with the aqueous composition, wherein the viscosity of the aqueous composition is increased by the compound compared to the viscosity of the aqueous composition before the contacting step.
18. A method of treating a material, the method comprising:
    contacting a material with an aqueous composition comprising a soy polysaccharide ether compound according to any one of embodiments 1-11 and 14.

EXAMPLES

The present disclosure is further exemplified in the following Examples. It should be understood that these Examples, while indicating certain preferred aspects herein, are given by way of illustration only. From the above discussion and these Examples, one skilled in the art can ascertain the essential characteristics of the disclosed embodiments, and without departing from the spirit and scope thereof, can make various changes and modifications to adapt the disclosed embodiments to various uses and conditions.

Preparation of Insoluble Soy Polysaccharide

Insoluble soy polysaccharide was prepared as a byproduct of the soy protein extraction procedure outlined in FIG. 2. Soy white flake, which was obtained after removing oil from soybeans, was subjected to protein extraction to isolate soy protein. Byproducts of the protein extraction process included insoluble polysaccharide ("spent flake"/"soy fiber" in FIG. 2) and soluble polysaccharides ("soy whey"/"molasses" in FIG. 2). The insoluble polysaccharide preparation comprised mostly insoluble polysaccharide (~85.8 wt%), but also some protein (~10.1 wt%), lipid (~0.8 wt%), and ash (~3.3 wt%) (see Table 7 below).

^{1}H Nuclear Magnetic Resonance (NMR) Method for Determining Molar Substitution of Soy Polysaccharide Ether Derivatives

Approximately 30 mg of soy polysaccharide ether derivative was weighed into a vial on an analytical balance. The vial was removed from the balance and 1.0 mL of deuterium oxide was added to the vial. A magnetic stir bar was added to the vial and the mixture was stirred to suspend the solid. Deuterated sulfuric acid (50% v/v in D_2O), 1.0 mL, was then added to the vial and the mixture was heated at 90 °C for 1 hour in order to depolymerize and solubilize the polymer. The solution was allowed to cool to room temperature and then a 0.8 mL portion of the solution was transferred into a 5-mm NMR tube using a glass pipet. A quantitative ^{1}H NMR spectrum was acquired using an Agilent VNMRS 400 MHz NMR spectrometer equipped with a 5-mm Autoswitchable Quad probe. The spectrum was acquired at a spectral frequency of about 399.945 MHz, using a spectral window of about 6410.3 Hz, an acquisition time of about 3.744 seconds, an inter-pulse delay of about 10 seconds and 64 pulses. The time domain data were transformed using exponential multiplication of 0.50 Hz.

EXAMPLE 1

Preparation of a Soy Polysaccharide Ether Derivative

This Example describes producing a dihydroxyalkyl ether derivative of soy polysaccharide. Specifically, dihydroxypropyl soy polysaccharide was produced.

10 g of insoluble soy polysaccharide (a dry, tan powder) was added to 139 mL of 2.89% sodium hydroxide in a 500-mL capacity round bottom flask fitted with a thermocouple for temperature monitoring and a condenser connected to a recirculating bath. This preparation was stirred with an overhead mixer and heated to 25 °C on a hotplate. The preparation was stirred for 1 hour (mercerization time) to swell the solid

before the temperature was increased to 70 °C. 3-chloro-1,2-propanediol (30 g) was then added to the preparation to provide an etherification reaction, which was held at 70 °C for 3.5 hours before being neutralized with acetic acid. After neutralization, an excess of isopropanol was added to precipitate a solid. The solid thus formed was collected by vacuum filtration and washed with ethanol (95%) four times, and dried under vacuum at 20-25 °C. The solid material obtained was identified as dihydroxypropyl soy polysaccharide that was partially water soluble, and having a degree of substitution (DoS) of 0.947. This process and its results are represented under sample 40 in Table 1.

Additional reactions were performed using different reagent amounts, reaction times and temperatures, leading to production of other dihydroxypropyl soy polysaccharide ether products. The results in Table 1 indicate that, by altering reaction conditions, the DoS by dihydroxypropyl groups in the ether product can be altered.

Table 1

Preparation of Dihydroxypropyl Soy Polysaccharide Ethers Using Various Reaction Conditions

Sample	Polymer Amount[a] (g)	Base	Base Conc.	Solvent[b]	Merc. Time[c]	Reagent[d] Amount (g)	Rxn Conditions		Prod. DoS	Prod. Viscosity (cPs) @ 73.54 rpm	
							Time	Temp.		no borate[h]	+ 1 wt% borate
4	10	tetraethyl ammonium hydroxide	20%	n/a		22.3	6 hr	55 °C	0.14	14.9	18.31
20	10	sodium hydroxide	6.50%	isopropanol		10.3	6 hr 45 min	55 °C	0.003	9.72	25.52
30	10	sodium hydroxide	7.70%	n/a	1 hr	30	7 hr	70 °C	0.74	19.44	64.4
31	10	sodium hydroxide	3.90%	n/a	1 hr	30	7 hr	70 °C	0.25	12.99	16.82
33	8	sodium hydroxide	5.40%	n/a	1 hr	30	6 hr	70 °C	0.94 (A)[i]	3.62(A)[i], 14.58(C)[i]	3.62(A)[i], 26.73 (C)[i]
37	10	sodium hydroxide	15%	isopropanol	1 hr	30	6 hr	55 °C		2.77	45.54
38	10	sodium hydroxide	15%	isopropanol	1 hr	30	6 hr	70 °C		4.26	6.81
40	10	sodium hydroxide	2.89%	n/a	1 hr	30	4.5 hr	70 °C	0.95	6.6	159.59
42A	10	sodium hydroxide	2.89%	n/a	30 min.	30	1 hr	70 °C	0.14	7.45	127.51
42B	10	sodium hydroxide	2.89%	n/a	30 min.	30	3 hr	70 °C	0.09	8.51	234.16
42C	10	sodium hydroxide	2.89%	n/a	30 min.	30	6 hr	70 °C	0.49	10.22	230.96
44A	10	sodium hydroxide	7.70%	n/a	30 min.	30	1 hr	70 °C	0.4	5.11	109.63
44B	10	sodium hydroxide	7.70%	n/a	30 min.	30	3 hr	70 °C	0.88	4.04	63.44

44C	10	sodium hydroxide	7.70%	n/a	30 min.	30	6 hr	70 °C	1.23	3.62	82.38
50	10	sodium hydroxide	50%	n/a	30 min.	30	23 hr	70 °C	1.98	n/a[e]	n/a[e]
51	2	sodium hydroxide	50%	toluene	30 min.	30	6 hr	70 °C	0.39	11.72	317.64
52	5	sodium hydroxide	50%	toluene	30 min.	30	6.5 hr	60 °C	0.29	7.81	27.34
82	5.5	tetraethyl ammonium hydroxide	40%	n/a	30 min.	8.8	6 hr	55 °C	0.84	5.32[f]	238.22[g]

[a] Starting amount of soy polysaccharide.

[b] Solvent used to precipitate product from etherification reaction.

[c] Mercerization time at 25 °C.

[d] Etherification reagent (3-chloro-1,2-propanediol).

[e] Ether product was not water-soluble; viscosity could not be measured.

[f] Viscosity (cPs) measured at 14.26 rpm.

[g] Viscosity (cPs) measured at 14.72 rpm.

[h] The measured viscosity of samples not treated with borate (refer to Example 2) was outside the specification limits of the instrument used.

[i] Reaction 33 produced semi-water-soluble products. The reaction was filtered to isolate soluble and insoluble fractions. Product A represents the soluble fraction, while C represents products prior to filtration (i.e., C is a mixture of soluble and insoluble products).

Thus, various forms of the ether derivative, dihydroxypropyl soy polysaccharide, were prepared and isolated. Most of these ethers had water-solubility.

EXAMPLE 2

Viscosity of Dihydroxypropyl Soy Polysaccharide Ether Derivatives

This Example describes the viscosity of solutions of various dihydroxypropyl soy polysaccharide ethers as prepared in Example 1. Viscosity was measured using ether samples alone, or ether samples that had been cross-linked via borate treatment.

Various solutions of soy polysaccharide ethers were prepared using ether samples produced in Example 1. Specifically, to prepare a 3 wt% solution of each of sample, 0.6 g of ether (particular samples from Table 1) was added to 19.4 g of DI water. Each preparation was then shaken on a bench top vortexer to dissolve the soy polysaccharide ether sample.

A portion of each ether solution was borate-cross-linked. Specifically, sodium tetraborate decahydrate was dissolved in a 3 wt% solution of each soy polysaccharide ether sample as prepared above. The final concentration of borate was 1 wt%.

To determine the viscosity of each soy polysaccharide ether solution at various shear rates, dissolved ether samples were subjected to 10, 60, 150, and 250 rpm shear rates using a Brookfield DV III+ viscometer at constant temperature (20 °C). The shear rate was increased using a gradient program which increased from 10-250 rpm and the shear rate was increased by 7.36 (1/s) every 20 seconds. The results of this experiment are listed in both Tables 1 and 2. Table 2 highlights viscosity results for samples 40, 42A, 42B, 42C, 44A, 44B, and 44C.

Table 2

Viscosity of Soy Polysaccharide Ether Solutions

Sample	Loading	Viscosity (cPs) @ 73.54 rpm	
		no borate[a]	+ 1 wt% borate
40 (DoS=0.947)	3 wt%	6.6	159.59
42A (DoS=0.137)	3 wt%	7.45	127.51
42B (DoS=0.088)	3 wt%	8.51	234.16

42C (DoS=0.486)	3 wt%	10.22	230.96
44A (DoS=0.396)	3 wt%	5.11	109.63
44B (DoS=0.883)	3 wt%	4.04	63.44
44C (DoS=1.227)	3 wt%	3.62	82.38

[a] The measured viscosity of samples not treated with borate (refer to Example 2) was outside the specification limits of the instrument used.

Thus, various forms of the ether derivative, dihydroxypropyl soy polysaccharide, exhibit elevated viscosity levels when cross-linked.

EXAMPLE 3

Preparation of an Alkyl Soy Polysaccharide Ether Derivative

This Example describes producing the alkyl soy polysaccharide ether derivative, methyl soy polysaccharide.

5-20 g (e.g., 10 g) of insoluble soy polysaccharide is added to 100-150 mL of 2-5% sodium hydroxide in a 500-mL capacity round bottom flask fitted with a thermocouple for temperature monitoring and a condenser connected to a recirculating bath. This preparation is stirred with an overhead mixer and heated to 25-30 °C on a hotplate. The preparation is stirred for 1-2 hour (mercerization time) to swell the solid before the temperature is increased to 55-70 °C. Methyl chloride (15-30 g) is then added to the preparation to provide an etherification reaction, which is held at 55-70 °C for 3-5 hours before being neutralized with acetic acid. After neutralization, an excess of isopropanol is added to precipitate a solid. The solid thus formed is collected by vacuum filtration and washed with ethanol four times, and dried under vacuum at 20-25 °C. The solid material obtained is methyl soy polysaccharide. Additional reactions can be performed using different reagent amounts, reaction times and temperatures, leading to production of other methyl soy polysaccharide ether products.

Thus, the alkyl soy polysaccharide ether derivative, methyl soy polysaccharide, is prepared and isolated.

EXAMPLE 4

Preparation of a Cationic Soy Polysaccharide Ether

This Example describes producing a quaternary ammonium ether derivative of soy polysaccharide. Specifically, trimethylammonium hydroxypropyl soy polysaccharide was produced. This ether is cationic.

5 g of soy polysaccharide (a dry, tan powder) was added to 40 mL of isopropanol in a 500-mL capacity round bottom flask fitted with a thermocouple for temperature monitoring and a condenser connected to a recirculating bath, and a magnetic stir bar. Sodium hydroxide (14.28 g of a 30% solution) was added dropwise to this preparation, which was then heated to 25 °C on a hotplate. The preparation was stirred for 1 hour before the temperature was increased to 55 °C. 3-chloro-2-hydroxypropyl-trimethylammonium chloride (15 g of a 60% solution) was then added to provide an etherification reaction, which was held at 55 °C for 2.5 hours before being neutralized with 90% acetic acid. The solid thus formed (trimethylammonium hydroxypropyl soy polysaccharide) was collected by vacuum filtration and washed with ethanol (95%) four times, dried under vacuum at 20-25 °C, and analyzed by NMR to determine DoS.

Additional reactions were performed using different reagent amounts and reaction times, leading to production of other trimethylammonium hydroxypropyl soy polysaccharide ether products. The results in Table 3 indicate that, by altering reaction conditions, the DoS by trimethylammonium hydroxypropyl groups in the ether product can be altered.

Table 3

Preparation of Trimethylammonium Hydroxypropyl Soy Polysaccharide Ethers Using Various Reaction Conditions

Sample	Polymer Amount[a] (g)	Base[b]		Base: Polymer Molar Ratio	Reagent Amount[c] (g)	Reagent: Polymer Molar Ratio	Rxn[d] Time (hr.)	Prod. DoS	Prod. Viscosity (cPs) @ 73.54 rpm
		Amt. (g)	Conc.						
1A	10	11.4	17.50%	0.798	31.15 (60%)	1.59	3	0.375	n/a[e]
1B	10	30	17.50%	2.1	32.4 (60%)	1.65	3	0.611	n/a[e]
3	10	40	15.00%	2.4	31.15 (60%)	1.59	3		n/a[e]
6	5	14.28	30.00%	3.424	23.6 (60%)	2.41	3	2.12	5.53[f]

8	5	14.3	30.00%	3.44	15 (60%)	1.53	3	0.698	3.19[f]
10	5	14.2	30.00%	3.36	10 (60%)	1.02	3		5.11[f]
11	5	14.2	30.00%	3.36	8.6 (60%)	0.88	3		4.04[f]
12	5	13	23.10%	2.4	10 (60%)	1.02	3		4.47[f]
14	5	13	23.10%	2.4	5.8 (60%)	0.59	2		4.26[f]
15	10	20	15.00%	1.2	14.7 (60%)	0.75	4	0.634	
17	10	14.5	17.50%	1.015	14.7 (60%)	0.75	4	0.617	
59	10	8	11.98%	3.2	58.78 (60%)	3.00	3.5	0.64	n/a[e]
60	10	14.97	11.31%	5.988	117.4 (60%)	5.99	2.5	3.1	n/a[e]
62	10	4	12.76%	1.6	31.35 (60%)	1.60	1.25	0.279	n/a[e]
64	5	2	10.71%	1.6	16.675 (60%)	1.70	4.5	0.576	n/a[e]
67	5	2	50.00%	0.8	5.1 (100%)	0.87	4	0.632	n/a[e]
68A	5	24.4	17.50%	3.416	20 (60%)	2.04	2	0.941	n/a[e]
68B	5	24.4	17.50%	3.416	30 (60%)	3.06	1.5	0.65	n/a[e]
69	5	12.2	17.50%	1.708	10 (60%)	1.02	1.5		n/a[e]
76A	10	17	50.00%	3.4	31.8 (60%)	1.62	1	0.358	n/a[e]
76B	10	17	50.00%	3.4	31.8 (60%)	1.62	5.5	0.251	n/a[e]

[a] Starting amount of soy polysaccharide.

[b] The listed amount (g) of sodium hydroxide solution (having a concentration as listed) was used.

[c] Amount (g) of etherification reagent 3-chloro-2-hydroxypropyl-trimethylammonium chloride(60% or 100% concentration) used. The concentration of the reagent is listed parenthetically.

[d] Reaction time was measured from the time etherification agent was added to the time of reaction neutralization.

[e] Ether product was not water-soluble; viscosity could not be measured.

[f] The measured viscosity of sample was outside the specification limits of the instrument used (refer to Example 2).

Thus, various forms of the cationic ether derivative, trimethylammonium hydroxypropyl soy polysaccharide, were prepared and isolated.

EXAMPLE 5

Effect of Shear Rate on Viscosity of Quaternary Ammonium Soy Polysaccharide

This Example describes the effect of shear rate on the viscosity of the quaternary ammonium soy polysaccharide ether derivative, trimethylammonium hydroxypropyl soy polysaccharide.

Various solutions of cationic soy polysaccharide ethers were prepared using ether samples produced in Example 1. Specifically, to prepare a 3 wt% solution of each of sample, 0.6 g of ether (particular samples from Table 1) was added to 19.4 g of DI water. Each preparation was then shaken on a bench top vortexer to dissolve the quaternary ammonium soy polysaccharide ether sample.

To determine the viscosity of each soy polysaccharide ether solution at various shear rates, dissolved ether samples were subjected to 10, 60, 150, and 250 rpm shear rates using a Brookfield DV III+ viscometer at constant temperature (20 °C). The shear rate was increased using a gradient program which increased from 10-250 rpm and the shear rate was increased by 7.36 (1/s) every 20 seconds. The results of this experiment are listed in both Tables 3 and 4. Table 4 highlights viscosity results for samples 6, 8, 10, 11, 12 and 14.

Table 4

Viscosity of Cationic Soy Polysaccharide Ether Solutions at Various Shear Rates

Sample	Loading	Viscosity (cPs) @ 66.18 rpm[a]	Viscosity (cPs) @ 102.9 rpm[a]	Viscosity (cPs) @ 183.8 rpm[a]	Viscosity (cPs) @ 250 rpm[a]
6 (DoS=2.12)	3 wt%	4.97	4.56	4	3.76
8 (DoS=0.698)	3 wt%	3.31	3.35	3.58	3.32
10	3 wt%	4.97	5.02	3.92	3.69
11	3 wt%	4.26	3.8	3.24	3.38
12	3 wt%	4.73	4.72	4.43	4.07
14	3 wt%	4.49	3.96	4.09	3.44

[a] The measured viscosity of each sample was outside the specification limits of the instrument used.

The results summarized in Table 4 appear to indicate that the viscosity of each solution of quaternary ammonium soy polysaccharide ether is reduced as shear rate is increased. This observation means that these solutions demonstrate shear thinning behavior.

Thus, a quaternary ammonium soy polysaccharide ether when dissolved in an aqueous solution not only modifies the viscosity of the solution, but also the rheological properties of the solution. Quaternary ammonium soy polysaccharide ether derivatives can therefore be added to an aqueous liquid to modify its rheological profile.

CLAIMS

What is claimed is:

1. A composition comprising a soy polysaccharide ether compound, wherein the compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.

2. The composition of claim 1, wherein the degree of substitution is less than 1.80.

3. The composition of claim 1, wherein at least one organic group is an alkyl, hydroxy alkyl, or carboxy alkyl group.

4. The composition of claim 3, wherein at least one organic group is a methyl, ethyl, hydroxypropyl, dihydroxypropyl, hydroxyethyl, or carboxymethyl group.

5. The composition of claim 1, wherein at least one organic group is a positively charged organic group.

6. The composition of claim 5, wherein at least one positively charged organic group comprises a substituted ammonium group.

7. The composition of claim 6, wherein the substituted ammonium group is a trimethylammonium group.

8. The composition of claim 6, wherein at least one positively charged organic group is a quaternary ammonium hydroxypropyl group.

9. The composition of claim 1, wherein:
    (i) the compound contains one type of organic group, or
    (ii) the compound contains two or more types of organic group.

10. The composition of claim 1, wherein the composition is an aqueous composition having a viscosity of at least about 3 cPs.

11. The composition of claim 10, wherein the aqueous composition is comprised in a personal care product, pharmaceutical product, food product, household product, or industrial product.

12. The composition of claim 1, wherein the compound is crosslinked.

13. The composition of claim 12, wherein the composition is an aqueous composition having a viscosity of at least about 50 cPs.

14. A method of producing a soy polysaccharide ether compound, the method comprising:
    (a) contacting soy polysaccharide in a reaction under alkaline conditions with at least one etherification agent comprising an organic group, wherein at least one organic group is etherified to the soy polysaccharide thereby producing a soy polysaccharide ether compound, wherein the compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0; and
    (b) optionally, isolating the soy polysaccharide ether compound produced in step (a).

15. A method for increasing the viscosity of an aqueous composition, the method comprising:
contacting a soy polysaccharide ether compound with the aqueous composition, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0, and wherein the viscosity of the aqueous composition is increased by said compound compared to the viscosity of the aqueous composition before the contacting step.

16. A method of treating a material, said method comprising:
contacting a material with an aqueous composition comprising a soy polysaccharide ether compound, wherein the ether compound has a degree of substitution with at least one organic group of about 0.0025 to about 3.0.

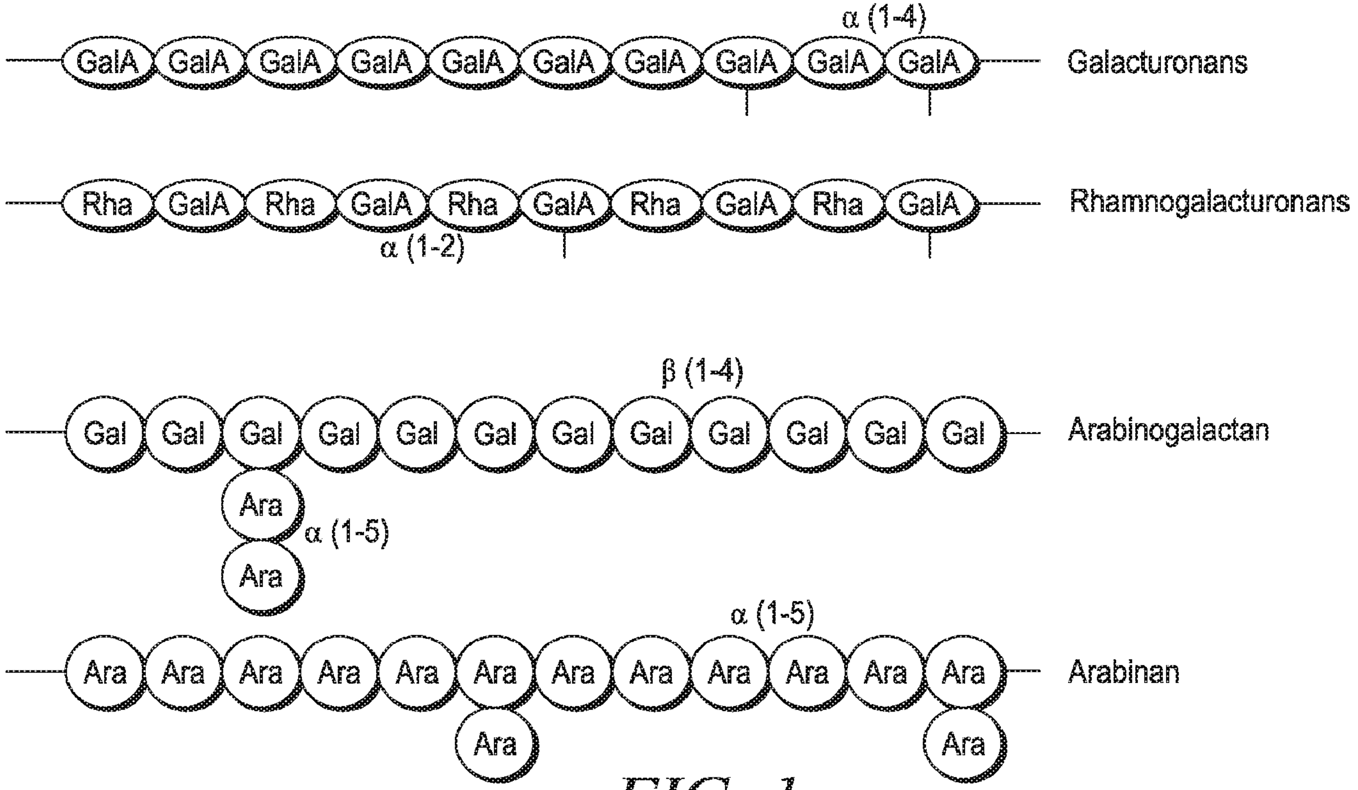

α (1-4)
GalA GalA GalA GalA GalA GalA GalA GalA GalA GalA
Galacturonans
Rha GalA Rha GalA Rha GalA Rha GalA Rha GalA
α (1-2)
Rhamnogalacturonans
β (1-4)
Gal Gal Gal Gal Gal Gal Gal Gal Gal Gal Gal Gal
Arabinogalactan
Ara
α (1-5)
Ara
α (1-5)
Ara Ara Ara Ara Ara Ara Ara Ara Ara Ara Ara Ara
Arabinan
Ara
Ara

FIG. 1

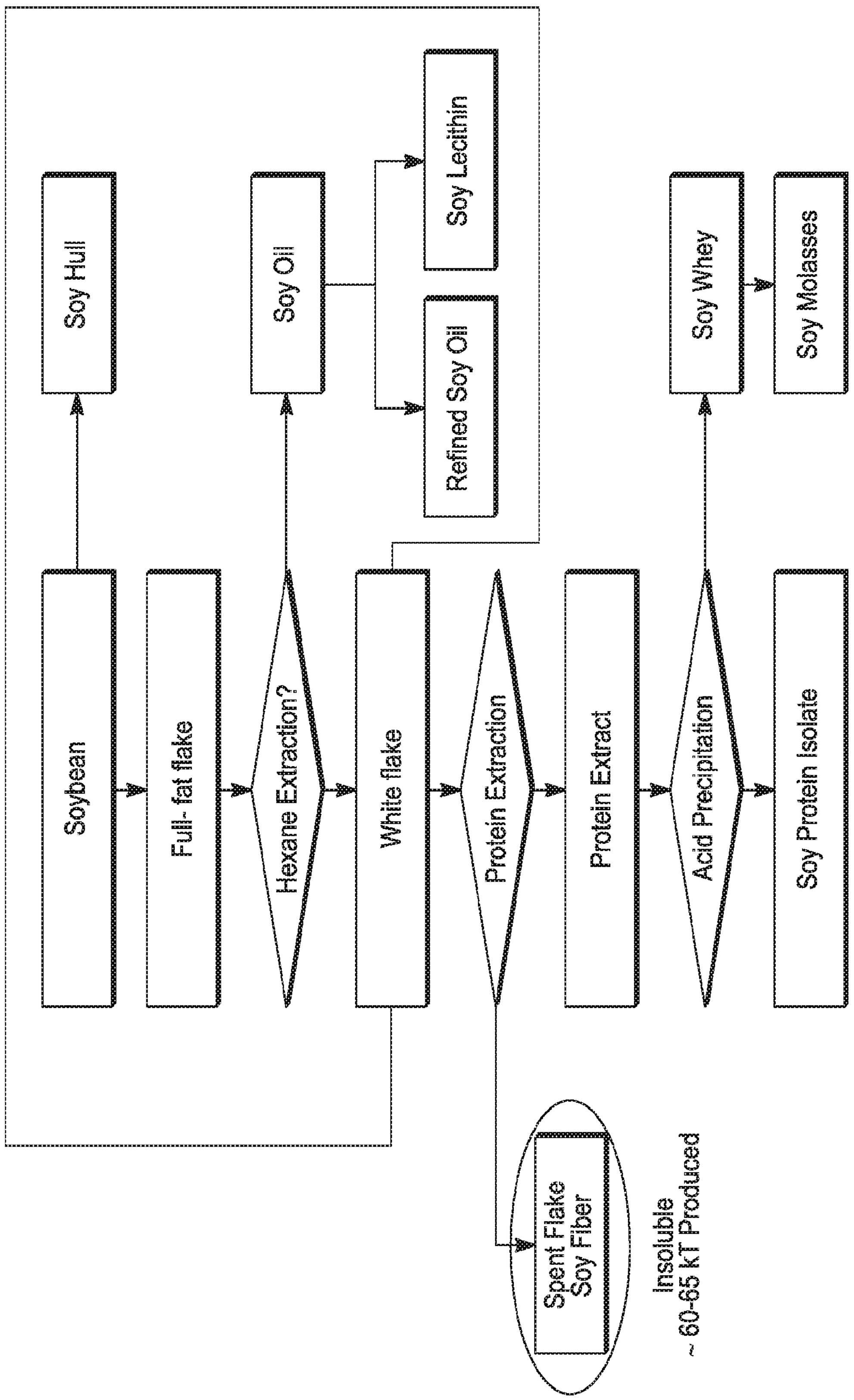

Soybean
Full- fat flake
Hexane Extraction?
White flake
Protein Extraction
Protein Extract
Acid Precipitation
Soy Protein Isolate
Soy Hull
Soy Oil
Refined Soy Oil
Soy Lecithin
Soy Whey
Soy Molasses
Spent Flake
Soy Fiber
Insoluble
~ 60-65 kT Produced

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/017066

A. CLASSIFICATION OF SUBJECT MATTER
INV. C08B11/02 C08B11/08 C08B11/14 C11D3/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C08B C11D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 146 395 A2 (RALSTON PURINA CO [US]) 26 June 1985 (1985-06-26) example 1	1-16
A	US 2002/046820 A1 (FURUNAGA TOSHIKATSU [JP] ET AL) 25 April 2002 (2002-04-25) the whole document	1-16
A	US 7 012 053 B1 (BARNABAS MARY VIJAYARANI [US] ET AL) 14 March 2006 (2006-03-14) the whole document	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2016	19/04/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Zellner, Armin

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/017066

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP 0146395 A2	26-06-1985
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