cross-metathesis of an internal olefin and an α-olefin in the presence of a ruthenium alkylidene catalyst (see U.S. Pat. Appl. Publ. No. 2010/0145086). A variety of cross-metathesis reactions involving an α-olefin and an unsaturated fatty ester (as the internal olefin source) are described. Thus, for example, reaction of soybean oil with propylene followed by hydrolysis gives, among other things, 1-decene, 2-undecenes, 9-decenoic acid, and 9-undecenoic acid. Despite the availability (from cross-metathesis of natural oils and olefins) of unsaturated fatty esters having reduced chain length and/or predominantly *trans*- configuration of the unsaturation, fatty amines and their derivatives made from these feedstocks appear to be unknown. Moreover, quaternized fatty amines and their derivatives have not been made from the C_{18} unsaturated diesters that can be made readily by self-metathesis of a natural oil.

In sum, traditional sources of fatty acids and esters used for making quaternized fatty amines and their derivatives generally have predominantly (or exclusively) *cis*-isomers and lack relatively short-chain (e.g., C_{10} or C_{12}) unsaturated fatty portions. Metathesis chemistry provides an opportunity to generate precursors having shorter chains and mostly *trans*- isomers, which could impart improved performance when the precursors are converted to downstream compositions (e.g., in surfactants). New C_{18} difunctional quaternized fatty amines and derivatives are also potentially available from oil or C_{10} unsaturated acid or ester self-metathesis. In addition to an expanded variety of precursors, the unsaturation present in the precursors allows for further functionalization, e.g., by sulfonation or sulfitation.

SUMMARY ~~OF THE INVENTION~~

In one ~~aspect~~embodiment, the ~~invention~~present disclosure relates to a quaternary ammonium, betaine, or sulfobetaine composition derived from a fatty amine, wherein the fatty amine is made from a metathesis-derived C_{10}-C_{17} monounsaturated acid, octadecene-1,18-dioic acid, or their ester derivatives. In another ~~aspect~~embodiment, the ~~invention~~present disclosure relates to a quaternary ammonium, betaine, or sulfobetaine composition derived from a fatty amidoamine, wherein the amidoamine is made by reacting a metathesis-derived C_{10}-C_{17} monounsaturated acid, octadecene-1,18-dioic acid, or their ester derivatives and an aminoalkyl-substituted tertiary amine such as DMAPA.

In one aspect, there is provided a quaternary ammonium, betaine, or sulfobetaine composition having (i) the formula:

$$R^2(R^3)N^+(R^1)R^4\ X^-$$

wherein:

R^1 is $-(CH_2)_8$-CH=CHR^5 or $-(CH_2)_8$-CH=CH-$(CH_2)_8$-$N^+(R^2)(R^3)R^4\ X^-$; each of R^2 and R^3 is independently substituted or unsubstituted alkyl, aryl, alkenyl, oxyalkylene, or polyoxyalkylene; R^4 is C_1-C_6 alkyl; X^- is a halide, bicarbonate, bisulfate, or alkyl sulfate; and R^5 is C_1-C_7 alkyl; or (ii) the formula:

$$R^2(R^3)N^+(R^1)R^4$$

wherein:

R^1 is $-(CH_2)_8$-CH=CHR^5 or $-(CH_2)_8$-CH=CH-$(CH_2)_8$-$N^+(R^2)(R^3)R^4$; each of R^2 and R^3 is independently substituted or unsubstituted alkyl, aryl, alkenyl, oxyalkylene, or polyoxyalkylene; R^4 is C_2-C_4 alkylene carboxylate, C_2-C_4 alkylene sulfonate, or C_2-C_4 hydroxyalkylene sulfonate; and R^5 is hydrogen or C_1-C_7 alkyl; and

wherein when R^5 is C_1-C_7 alkyl, the composition has at least 1 mole % of *trans*-Δ^9 unsaturation.

In another aspect, there is provided a quaternary ammonium, betaine, or sulfobetaine composition having (i) the formula:

$$R^4(R^3)(R^2)N^+(CH_2)_nNH(CO)R^1\ X^-$$

wherein:

R^1 is $-(CH_2)_7$-CH=CH-R^5 or $-(CH_2)_7$-CH=CH-$(CH_2)_7$-$(CO)NH(CH_2)_nN^+(R^2)(R^3)R^4\ X^-$; each of R^2 and R^3 is independently substituted or unsubstituted alkyl, aryl, alkenyl, oxyalkylene, or polyoxyalkylene; R^4 is C_1-C_6 alkyl; X^- is a halide, bicarbonate, bisulfate, or alkyl sulfate; R^5 is hydrogen or C_1-C_7 alkyl; and n= 2 to 8; or (ii) the formula:

$$R^4(R^3)(R^2)N^+(CH_2)_nNH(CO)R^1$$

wherein:

R^1 is $-(CH_2)_7$-CH=CH-R^5 or $-(CH_2)_7$-CH=CH-$(CH_2)_7$-$(CO)NH(CH_2)_nN^+(R^2)(R^3)R^4$; each of R^2 and R^3 is independently substituted or unsubstituted alkyl, aryl, alkenyl, oxyalkylene, or polyoxyalkylene; R^4 is C_2-C_4 alkylene carboxylate, C_2-C_4 alkylene sulfonate, or C_2-C_4 hydroxyalkylene sulfonate; R^5 is hydrogen or C_1-C_7 alkyl; and n= 2 to 8; and

wherein when R^5 is C_1-C_7 alkyl, the composition has at least 1 mole % of *trans*-Δ^9 unsaturation.

In another aspect, there is provided a derivative made by sulfonating or sulfitating the composition as defined above.

The ~~invention~~present disclosure includes

derivatives made by sulfonating or sulfitating the quaternized fatty amines or amidoamines. In one ~~aspect~~embodiment, the ester derivative of the C_{10}-C_{17} monounsaturated acid or octadecene-1,18-dioic acid is a lower alkyl ester. In other ~~aspect~~embodiments, the ester derivative is a modified triglyceride made by self-metathesis of a natural oil or an unsaturated triglyceride made by cross-metathesis of a natural oil with an olefin. The quaternary ammonium, betaine, and sulfobetaine compositions and their sulfonated or sulfitated derivatives are valuable for a wide variety of end uses, including cleaners, fabric treatment, hair conditioning, personal care (liquid cleansing products, conditioning bars, oral care products), antimicrobial compositions, agricultural uses, and oil field applications.

In an aspect, there is provided a glyphosate formulation, a water-soluble herbicide composition, or an antimicrobial composition each comprising the quaternary ammonium, betaine, or sulfobetaine composition as defined above or the derivative as defined above.

In another aspect, there is provided a hard-surface cleaner, a laundry detergent formulation, a shampoo or hair conditioner, or a personal cleanser or handsoap each comprising the quaternary ammonium, betaine, or sulfobetaine composition as defined above or the derivative as defined above.

In another aspect, there is provided a corrosion inhibitor, a paraffin dispersant, or a gas well foamer each comprising the quaternary ammonium, betaine, or sulfobetaine composition as defined above or the derivative as defined above.

In another aspect, there is provided a foamer, foam additive, or dispersant comprising the quaternary ammonium, betaine, or sulfobetaine composition as defined above or the derivative as defined above.

In another aspect, there is provided an anionic emulsifier comprising the quaternary ammonium, betaine, or sulfobetaine composition as defined above or the derivative as defined above.

DETAILED DESCRIPTION OF THE INVENTION

In one aspect, the invention relates to a quaternary ammonium, betaine, or sulfobetaine composition derived from a fatty amine. The fatty amine is made from a metathesis-derived C_{10}-C_{17} monounsaturated acid, octadecene-1,18-dioic acid, or their ester derivatives.

The C_{10}-C_{17} monounsaturated acid, octadecene-1,18-dioic acid, or their ester derivatives used as a reactant is derived from metathesis of a natural oil. Traditionally, these materials, particularly the short-chain acids and derivatives (e.g., 9-decylenic acid or 9-dodecylenic acid) have been difficult to obtain except in lab-scale quantities at considerable expense. However, because of the recent improvements in metathesis catalysts, these acids and their ester derivatives are now available in bulk at reasonable cost. Thus, the C_{10}-C_{17} monounsaturated acids and esters are conveniently generated by cross-metathesis of natural oils with olefins, preferably α-olefins, and particularly ethylene, propylene, 1-butene, 1-hexene, 1-octene, and the like. Self-metathesis of the natural oil or a C_{10} acid or ester precursor (e.g., methyl 9-decenoate) provides the C_{18} diacid or diester in optimal yield when it is the desired product.

Preferably, at least a portion of the C_{10}-C_{17} monounsaturated acid has "Δ^9" unsaturation, i.e., the carbon-carbon double bond in the C_{10}-C_{17} acid is at the 9- position with respect to the acid carbonyl. In other words, there are preferably seven carbons between the acid carbonyl group and the olefin group at C9 and C10. For the C_{11} to C_{17}