SAKE REPLICAS PRODUCED FROM INDIVIDUAL COMPONENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a claims priority to U.S. Provisional Application Serial No. 62/861,146, filed on June 13, 2019, incorporated by reference herein in its entirety.

TECHNICAL FIELD

This document relates to materials and methods for producing sakes from individual components.

BACKGROUND

Traditional methods for producing alcoholic beverages are often lengthy and costly, involving the harvesting of fastidious crops, followed by processing, fermenting, and aging steps. Each component of the traditional process has an inherent variability and risk, including climate, crop disease, and contamination, which can render such methods and their resulting products inconsistent. The use of traditional sake production methods requires difficult controls for variability, often involving adulteration of the final product with ingredients to mask imperfections.

SUMMARY

In one aspect, the present disclosure refers to a sake replica comprising:

ethanol;

water; and

one or more additional VOCs, wherein the one or more additional VOCs do not comprise at least one compound selected from the group consisting of 2,3-pentadione, 1-octanol, 2-heptanone, 2-nonanone, 5-methyl furfural, benzaldehyde, benzyl alcohol, butyl acetate, butyraldehyde, citronellol, diethyl succinate, ethyl isobutyrate, ethyl lactate, ethyl propionate, ethyl trans-2-butenoate, ethyl(methylthio) acetate, gamma-heptalactone, gamma-hexalactone, gamma-octalactone, hexanol, isoamyl hexanoate, isobutyl acetate, isobutyraldehyde, isobutyric acid, isovaleric acid, methionyl acetate,

methyl acetate, nonanoic acid, phenylacetaldehyde, propionaldehyde, propionic acid, propyl acetate, and propyl butyrate.

In another aspect, the present disclosure refers to a sake replica comprising:

ethanol;

water; and

one or more non-volatile compounds, wherein the one or more non-volatile compounds comprise at least one compound selected from the group consisting of cinnamic acid, 2,3,5-trimethylpyrazine, 2,3-dimethylpyrazine, aspartic acid, caffeic acid, camphoric acid, catechin, cysteine, cystine, ellagic acid, epicatechin, epicatechin gallate, gallic acid, hesperetin, methyl gallate, methyl-2-pyrrolyl ketone, inositol, propyl gallate, pyridine, quercetin, resveratrol, sinapinic acid, sorbic acid, syringaldehyde, and tryptamine.

In yet another aspect, the present disclosure refers to a sake replica comprising:

ethanol;

water; and

one or more additional VOCs, wherein the additional VOCs comprise 2-methyl-1-butanol, 2-phenylethanol, acetaldehyde, butyl alcohol, ethyl acetate, ethyl butanoate, ethyl hexanoate, ethyl octanoate, furfural, isoamyl acetate, isoamyl alcohol, isobutyl alcohol, phenethyl acetate, and propanol.

In a further aspect, the present disclosure refers to a method of making a sake replica, the method comprising:

combining ingredients comprising:

water;

ethanol;

five or more additional VOCs, wherein at least five of the five or more additional VOCs are provided as separate ingredients; and

five or more non-volatile compounds, wherein at least five of the five or more non-volatile compounds are provided as separate ingredients.

In another aspect, the present disclosure refers to a sake replica produced by the method disclosed herein.

In yet another aspect, the present disclosure refers to a sake replica comprising:

ethanol;

water;

additional volatile organic compounds (VOCs); and

non-volatile compounds,

wherein the additional VOCs comprise:

Compound (mg/L, unless otherwise specified)	
acetaldehyde	17 - 32
butyl alcohol	3 - 7
propyl alcohol	5 - 11
ethyl acetate	45 - 85
ethyl butanoate	0.4 - 0.8
ethyl hexanoate	2 - 4
ethyl octanoate	2.5 - 5.5
furfural	4 - 10
isoamyl acetate	0.5 - 1
isoamyl alcohol	70 - 130
isobutyl alcohol	14 - 26
phenethyl acetate	0.1 - 0.2
phenethyl alcohol	4 - 9
2-methyl-1-butanol	10 - 19

and wherein the non-volatile compounds comprise:

Compound (mg/L, unless otherwise specified)	
arginine	225 - 420
alanine	60 - 120
choline bitartrate	400 - 750
fructose	300 - 600
glucose	25000 - 50000
D-glucuronic acid	20 - 45
malic acid	330 - 620

Compound (mg/L, unless otherwise specified)	
sorbitol	25 - 50
fumaric acid	0.25 - 0.6
glutamic acid	100 - 200
citric acid	35 - 70
isoleucine	35 - 65
tartaric acid	0.1 - 0.25
lactic acid (mL/L)	280 - 530
lysine HCl	20 - 45
phenylalanine	40 - 90
threonine	9 - 16
cinnamic acid	16 - 32
succinic acid	200 - 400
KOH	250 - 500

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This document is based, at least in part, on the discovery that compounds that contribute to the flavor and aroma of various alcoholic beverages (e.g., sakes) can be identified and combined to yield alcoholic beverage replicas that have the taste, aroma, and other characteristics of traditionally generated alcoholic beverages. Because each ingredient is added individually, the methods disclosed herein can reduce many of the risks and variability associated with traditional production of alcoholic beverages. In some cases, one or more ingredients (e.g., at least 50%, 60%, 70%, 80%, 90%, 95%, 99%, or 100% of the ingredients) can be highly defined (e.g., by lot analysis). In some cases, one or more ingredients (e.g., at least 50%, 60%, 70%, 80%, 90%, 95%, 99%, or 100% of the ingredients) can be highly pure (e.g., at least 90%, 95%, 96%, 97%, 98%,

99%, 99.5%, or 99.9% pure). The methods also can provide infinite reproducibility of a recipe, which is not possible with traditional production methods. Further, the methods described herein allow for unique flexibility in optimization of the flavors, aromas, and textures of sakes, and greatly reduce or even eliminate the possibility that the resulting sakes will contain detrimental or undesired components. Moreover, the methods disclosed herein differ from currently existing methods in that they are rapid, reproducible, and cost-effective.

There are several types of traditional sakes. Junmai is a sake that is made from rice only, with no addition of distilled alcohol. Honjozo is a sake to which a small amount of distilled alcohol is added. Ginjo is a sake made from highly milled rice, with additional alcohol added. Junmai Ginjo is a sake made from highly milled rice, without additional alcohol added. Daiginjo is a sake made from even more highly milled rice than Ginjo, with additional alcohol. Junmai Daiginjo is its counterpart without additional alcohol added. Nama-zake is a sake that has not been pasteurized. Nigorizake is a sake that is unfiltered.

Traditional sakes can be further categorized. Seishu is the legal name for sake, differentiating it from other alcoholic beverages. Futsuu-shu is any sake that is not junmai, honjozo, ginjo-shu or daiginjo; this loosely translates to "value-sake." Jizake is a somewhat vague term that usually means sake made in smaller breweries located in distant areas, or sake that is not mass-produced (ie “craft sake”).

In some examples~~embodiments~~, sake replicas as described herein can be replicas of any of these types of sakes. In some examples~~embodiments~~, sake replicas described herein can be a replica of a blend of two or more types of sakes.

Traditional sakes are complex mixtures on a chemical level. In some ~~aspects~~examples, this document provides sake replicas that are less complex than a traditional sake. It was surprising that the replicas disclosed herein do not need to have the complexity of a traditional sake in order to be perceived as such. It was also surprising that some compounds, which by themselves have an unpleasant taste and/or smell, can enhance the taste and/or smell of the sake replicas disclosed herein. It was further surprising that the exclusion of some compounds found in all tested traditional sakes was not detrimental to

the sake replicas described herein. Similarly, it was surprising that some compounds that were not found in any tested traditional sake could be beneficial to the sake replicas described herein. It was also surprising that sake replicas described herein containing some compounds in amounts greater than the highest measured amount in any tested traditional alcoholic beverage or lower than the lowest measured amount in any tested traditional sake were superior to replicas that contained the same compounds in amounts within the measured range of traditional sake. Therefore, in another ~~aspect~~example, this document provides sake replicas that are not mere replicas of existing products, but instead provide a similar sensory experience with a different chemical composition.

In one example~~aspect~~, this document features a sake replica that includes ethanol, water, and one or more additional volatile organic compounds (VOCs), where the one or more additional VOCs include at least one VOC that is not present in a corresponding traditional sake. In some cases, the one or more additional VOCs do not include at least one VOC that is present in a corresponding traditional sake. This document also features a sake replica that includes ethanol, water, and one or more additional VOCs, where the one or more additional VOCs do not include at least one VOC that is present in a corresponding traditional sake.

The one or more additional VOCs can include one or more, two or more, three or more, four or more, five or more, six or more, or all seven of butyl formate, ethyl octanoate, ethyl propionate, ethyl-2-methylbutyrate, isoamyl acetate, isoamyl alcohol, and isobutanol. In some cases, the one or more additional VOCs include no more than six, no more than five, or no more than four of butyl formate, ethyl octanoate, ethyl propionate, ethyl-2-methylbutyrate, isoamyl acetate, isoamyl alcohol, and isobutanol.

The sake replica can further include one or more non-volatile compounds, where the one or more non-volatile compounds include at least one compound that is not present in a corresponding traditional sake. The sake replica can further include one or more non-volatile compounds, where the one or more non-volatile compounds do not include at least one non-volatile compound that is present in a corresponding traditional sake.

The one or more additional VOCs can include an ester, an alcohol, an aldehyde, a ketone, or an aldehyde and a ketone, optionally, an acid, optionally, a terpene, an

isoprenoid, or a terpene and an isoprenoid, optionally, a phenol, optionally, a lactone; optionally, an amine, a pyrazine, or an amine and a pyrazine, optionally, a thiol, a thiazole, a sulfide, or any combination thereof, optionally, an ether, optionally, an acetal; and optionally, a furan.

The sake replica can further include one or more non-volatile compounds. The one or more non-volatile compounds can have less than 90%, less than 80%, less than 70%, less than 60%, less than 50%, less than 40% identity, less than 30% identity, or less than 25% identity to the non-volatile compounds in a corresponding traditional sake.

The one or more additional VOCs can have less than 90%, less than 80%, less than 70%, less than 60%, less than 50%, less than 40% identity, less than 30% identity, less than 25% identity, less than 20% identity, or less than 15% identity to the VOCs in a single corresponding traditional sake.

In one example~~aspect~~, this document features a sake replica that includes ethanol, water, and one or more additional volatile organic compounds (VOCs), where the one or more additional VOCs include at least one VOC that is not present in a corresponding traditional sake. In some cases, the one or more additional VOCs do not include at least one VOC that is present in a corresponding traditional sake. This document also features a sake replica that includes ethanol, water, and one or more additional VOCs, where the one or more additional VOCs do not include at least one VOC that is present in a corresponding traditional sake. In some cases, the one or more additional VOCs include at least one VOC that is not present in a corresponding traditional sake.

In another example~~aspect~~, this document features a sake replica that includes ethanol, water, and one or more non-volatile compounds, where the one or more non-volatile compounds include at least one non-volatile compound that is not present in a corresponding traditional sake. In some cases, the one or more non-volatile compounds do not include at least one non-volatile compound that is present in a corresponding traditional sake. This document also features a sake replica that includes ethanol, water, and one or more non-volatile compounds, where the one or more non-volatile compounds do not include at least one non-volatile compound that is present in a corresponding

oxysporum, *Fusarium oxysporum*, *Mortierella alpina*, *Mucor plumbeus*, *Paecilomyces viridis*, *Penicillium chrysogenum*, *Penicillium citreonigrum*, *Penicillium decumbens*, *Penicillium purpurogenum*, *Trichoderma longibrachiatum*, *Trichoderma viride*, *Verticillium psalliotae*, mold, mildew, rot, insects, insect eggs, insect filth, rodent filth, mammalian excreta, insect lecithins, hydrogen sulfide, hydrogen disulfide, 2,4,6-trichloranisole, 2,4,6,-tribromoanisole, aflatoxin, aldrin, dieldrin, benzene hexachloride, chlordane, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyldichloroethane (TDE), dimethylnitrosamine (nitrosodimethylamine), ethylene dibromide (EDB), heptachlor, heptachlor epoxide, lindane, mercury, methanol, ethylene glycol, and dichloromethane.

In another example~~aspect~~, provided herein is a sake replica including ethanol, water, and one or more additional VOCs, wherein the additional VOCs include 2-methyl-1-butanol, 2-phenylethanol, acetaldehyde, butyl alcohol, ethyl acetate, ethyl butanoate, ethyl hexanoate, ethyl octanoate, furfural, isoamyl acetate, isoamyl alcohol, isobutyl alcohol, phenethyl acetate, and propanol. In some examples~~embodiments~~, the sake replica can further include one or more non-volatile compounds, wherein the non-volatile compounds include alanine, arginine, choline bitartrate, cinnamic acid, citric acid, D-glucuronic acid, fructose, fumaric acid, glucose, glutamic acid, isoleucine, KOH, lysine, malic acid, phenylalanine, sorbitol, succinic acid, tartaric acid, and threonine.

In another example~~aspect~~, provided herein is a sake replica including ethanol, water, and one or more non-volatile compounds, wherein the non-volatile compounds include alanine, arginine, choline bitartrate, cinnamic acid, citric acid, D-glucuronic acid, fructose, fumaric acid, glucose, glutamic acid, isoleucine, KOH, lysine, malic acid, phenylalanine, sorbitol, succinic acid, tartaric acid, and threonine. In some examples~~embodiments~~, the sake replica can further include one or more additional VOCs, wherein the additional VOCs include 2-methyl-1-butanol, 2-phenylethanol, acetaldehyde, butyl alcohol, ethyl acetate, ethyl butanoate, ethyl hexanoate, ethyl octanoate, furfural, isoamyl acetate, isoamyl alcohol, isobutyl alcohol, phenethyl acetate, and propanol.

In another example~~aspect~~, provided herein is a method of making a sake replica, the method including combining ingredients including water, ethanol, five or more additional

hexanoate, ethyl octanoate, furfural, isoamyl acetate, isoamyl alcohol, isobutyl alcohol, phenethyl acetate, and propanol. The non-volatile compounds can include alanine, arginine, choline bitartrate, cinnamic acid, citric acid, D-glucuronic acid, fructose, fumaric acid, glucose, glutamic acid, isoleucine, KOH, lysine, malic acid, phenylalanine, sorbitol, succinic acid, tartaric acid, and threonine.

In another example~~aspect~~, provided herein is a sake replica produced by the any of the methods provided herein. In some examples~~embodiments~~, a sake replica can be any of the sake replicas provided herein.

In another example~~aspect~~, provided herein is a method of sake replica concentrate, the method including combining ethanol, water, and one or more additional VOCs, wherein at least one of the one or more additional VOCs can be present in a concentration of at least about 2-fold the concentration of the same VOC in a corresponding traditional sake.

Implementations can include one or more of the following features. The method can include using 5 or more additional VOCs, wherein at least 5 of the 5 or more additional VOCs can be provided as separate ingredients. The method can include using 10 or more additional VOCs, wherein at least 10 of the 10 or more additional VOCs can be provided as separate ingredients. The additional VOCs can include one or more VOCs that is not present in a corresponding traditional sake. The one or more VOCs that is not present in a corresponding traditional sake can be selected from the group consisting of 1,4-cineole, 1-decanol, 2,4,6-trimethylphenol, 2-acetyl-1-methylpyrrole, 2-ethyl-3(5 or 6)-dimethylpyrazine , 2-ethyl-3-methylpyrazine, 2-isopropyl-4-methyl thiazole, 2-methoxy-3-(1-methylpropyl) pyrazine, 2-methoxy-4-methylphenol, 2-methoxy-4-propylphenol, 2-methylbutyl acetate, 2-methylbutyl isovalerate, 2-nonanol, 3-carene, 3-methylthio hexyl acetate, 3-phenylpropanal, 4,5,6,7-tetrahydro-3,6-dimethylbenzofuran, 4-carvomenthenol, 4-mercapto-4-methyl-2-pentanone, 5-methyl-2-phenyl-2-hexenal, acetoin, a-ionone, allyl heptanoate, alpha-pinene, amyl alcohol, amyl butyrate, anisyl acetate, anisyl butyrate, b-caryophellene, benzyl acetate, benzyl benzoate, benzyl butyrate, benzyl formate, benzyl propionate, beta-ionone, butyl butyryllactate, butyl formate, carvacrol, cinnamaldehyde, cis-3-hexenyl acetate, cis-3-hexenyl butyrate, cis-3-hexenyl valerate, cis-5-octen-1-ol, cis-6-nonen-1-ol, citral, citronellal, cuminaldehyde, D-

include one or more non-volatile compounds that is not present in a corresponding traditional sake. The one or more non-volatile compounds that is not present in a corresponding traditional sake can be selected from the group consisting of 2,3,5-trimethylpyrazine, 2,3-dimethylpyrazine, aspartic acid, caffeic acid, camphoric acid, catechin, cinnamic acid, cysteine, cystine, ellagic acid, epicatechin, epicatechin gallate, gallic acid, hesperetin, methyl gallate, methyl-2-pyrrolyl ketone, inositol, propyl gallate, pyridine, quercetin, resveratrol, sinapinic acid, sorbic acid, syringaldehyde, and tryptamine. The non-volatile compounds can not include one or more non-volatile compounds that is present in a corresponding traditional sake. The one or more non-volatile compounds that is present in a corresponding traditional sake can be selected from the group consisting of 2,3,5,6-tetramethylpyrazine, 2-furoic acid, 2-isopropylmalic acid, 3,4-dihydroxybenzoic acid, 4-guanidinobutyric acid, asparagine, beta-alanine, carnitine, fucose, GABA, galactose, glucosamine, glutamine, glycine, guanine, histidine, lactic acid, leucine, mannitol, mannose, methionine, ornithine, proline, pyridoxine, pyruvic acid, quinic acid, rhamnose, salicylic acid, serine, tryptophan, tyrosine, valine, and xylose. The non-volatile compounds include alanine, arginine, choline bitartrate, cinnamic acid, citric acid, D-glucuronic acid, fructose, fumaric acid, glucose, glutamic acid, isoleucine, KOH, lysine, malic acid, phenylalanine, sorbitol, succinic acid, tartaric acid, and threonine.

In another example~~aspect~~, also provided herein is a sake replica concentrate produced by any of the methods provided herein. In some examples~~embodiments~~, the sake replica concentrate, when diluted, can be any of the sake replicas provided herein.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this ~~invention~~ present disclosure pertains. Although methods and materials similar or equivalent to those described herein can be used to practice the present disclosure~~invention~~, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

The details of one or more examples~~embodiments~~ of the present disclosure ~~invention~~ are set forth in the description below. Other features, objects, and advantages of the present disclosure ~~invention~~ will be apparent from the description and from the claims.

DETAILED DESCRIPTION

This document provides sake replicas, as well as methods for making alcoholic beverage replicas by combining water and ethanol with individual VOCs and non-volatile organic compounds. The sake replicas described herein have characteristics – including taste, aroma, mouthfeel, and appearance – of traditionally generated sakes, and are meant to be consumed and enjoyed in the same manner as traditional sakes.

As used herein, the terms "traditional" and "reference" sakes refer to sakes produced through standard fermentation that include the fermentation of rice plant matter. "Traditionally-produced" sakes are sakes that are generated using standard processes.

In some embodiments, a sake replica can consist of the ingredients included in a particular list, or can have a VOC content (or non-volatile compound content) that consists of the VOCs or non-volatile compounds included in a particular list. Further, a sake replica can consist essentially of the ingredients included in a particular list, or can have a VOC content (or non-volatile compound content) that consists essentially of the VOCs or non-volatile compounds that are included in a particular list. By "consisting essentially of" is meant that a sake replica contains specified ingredients/VOCs/non-volatile compounds, and can contain additional ingredients/VOCs/non-volatile compounds that do not materially affect the basic and novel characteristics of the sake replica.

In general, the sake replicas include the following components, or classes of components:

a) a source of water, either pure or with mineral content present to improve flavor;

b) a source of distilled ethanol with a concentration between about 20% and 100% weight by volume;

c) one or more VOCs; and

d) one or more non-volatile compounds.