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(54) Title: BEVERAGE WITH INCREASED SHELF LIFE

(57) Abstract: The present invention pertains to a beverage for animal or human consumption comprising 0.01 ppm to 0.1 wt. % of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O. The addition of a food-compatible antimicrobial gas increases the shelf life of the beverage and may also contribute to the microbiological food safety of the product.



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Beverage with increased shelf life

The present invention pertains to a beverage with increased shelf life, and to a method for increasing the shelf life of beverages.

For numerous beverages there is need for a method for increasing their shelf life, especially during the period before opening. This will lead to increased processing and distribution flexibility. A suitable method will be safe, relatively inexpensive, and should not detrimentally affect the taste, mouth feel, colour, or other pertinent properties of the product in a substantial manner.

In the art, various methods are known to increase the shelf life and the microbiological food safety of beverages. Examples include heating, packaging the beverage in gas-tight containers, decreasing the pH of the product, and the addition of various antimicrobial components.

Further, in the art various processes have been described where gases are added to beverages.

In some cases, the aim is to preserve the quality of a beverage by selecting a specific ratio between oxygen and carbon dioxide. For example, WO 93/07765 describes a method for the preservation of fresh orange juice wherein the juice is brought into contact with an atmosphere containing oxygen and CO₂, and brought into a high gas barrier container, followed by sealing the container and rapidly cooling the gas in the container. On the other hand, in US 2002/0044994 the aim is to improve the aromas or the flavour of a citrus juice by injecting it with a gas containing an element selected from the group of argon, krypton, neon, xenon, or a mixture thereof to substantially saturate the beverage with said gas or gas mixture. Outside the beverage field, US 4,411,921 describes a

method for preventing growth of harmful fungi on fruits and vegetables by keeping them in an atmosphere comprising CO, CO₂, oxygen and nitrogen.

5 Replacing oxygen with CO₂ to control the growth of aerobic bacteria is also known in the art. For example, JP52005576 describes a container for carbonated beverages equipped with an enlarged head space, where the air in the headspace is replaced with carbon dioxide.

10 Obviously, gas is often used to produce pressurised canned drinks. For an example, reference is made to JP58101667, which describes a canned drink containing juice sacs of a citrus fruit and filling an inert gas therein.

Gases may also be used for disinfecting food by applying
15 pressure. For example, WO2003/094637 describes a treatment process for preserving a food or food product against microbiological contamination using a high-pressure gas treatment process. The process is carried out to substantially sanitize or disinfect the food following depressurization.

20 Finally, gases may be used as disinfectant. Devico N.J. (There must be a better way, Food quality May/June 20-21, 22, 24, 26-29, 2003) describes a method for treating water with ozone. Outside the beverage field, US 5,693,354 describes a method for washing vegetables using a liquid containing an
25 antimicrobial amount of CO₂ and sufficient argon to suppress the disadvantageous bleaching and oxidising effect of the CO₂.

While some of the references discussed above address the issue of improving the shelf-life of beverages, there is still
30 need for an additional method for increasing the shelf life of beverages which method is safe, relatively inexpensive, and which does not detrimentally affect the pertinent properties of the product. The present invention provides such a method. The present invention also provides a beverage with improved

shelf life. Additionally, the present invention may also contribute to the microbiological food safety of the beverage.

In the method of the present invention, the shelf life of beverages for animal or human consumption is improved by adding 0.01 ppm to 0.1 wt.% of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O to the beverage, after which the liquid is sealed in a gas-impermeable container. As will be discussed in more detail below, depending on the pH of the beverage, the present invention may also increase the microbiological food safety of the beverage.

It is the merit of the present invention to recognise that the addition of very small amounts of an antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O to the beverage can be used to increase shelf life and optionally the microbiological food safety of beverages. This enables the provision of beverages with improved shelf life at low cost, and without detrimentally affecting the pertinent properties of the beverage. Further advantages of the present invention will become evident from the rest of the specification. The present invention can be applied to cooled beverages, and to beverages stored under ambient conditions. The invention can be applied to ready-to-drink beverages, but also to beverage intermediate products like concentrates and syrups.

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The beverage according to the present invention comprises 0.01 ppm to 0.1 wt.% of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O. In the present specification ppms and percentages refer to the concentration of gas dissolved in the beverage.

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The use of an antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O will, in the amount used in the beverage under beverage storage conditions, result in a significant reduction in growth rate, a significant extension in lag phase

and/or a significant reduction in the number of viable micro-organisms. The microbial activity is measured either by OD (optical density) measurements or by plate counts.

More in particular, the growth rate is reduced by at least 25%, in particular at least 50%, more in particular at least 75%, as compared to the growth rate in the absence of the gas. Alternatively or additionally, the lag phase is extended by at least 25%, in particular at least 50%, more in particular at least 75%, as compared to the lag phase in the absence of the gas. Alternatively or additionally, the number of viable micro-organisms is reduced by at least 25%, in particular at least 50%, more in particular at least 75%, as compared to the number of viable micro-organisms in the absence of the gas.

The concentration of antimicrobial gas dissolved in the liquid is calculated from the partial pressure of the antimicrobial gas above the liquid using Henry's law.

A formula for Henry's Law is:

$$e^p = e^{kc}$$

where:

p is the partial pressure of the gas above the liquid

c is the concentration of the gas in the solution

k is the Henry's Law constant, which is differs per gas and can be found in literature.

In accordance with the invention, shelf life of a beverage is increased by the presence of an antimicrobial gas, which decreases the activity of micro-organisms (e.g. fungi, including yeast, and bacteria) in the product. The microbiological food safety may be increased by decreasing the

activity of (pathogenic) bacteria in the beverage. Whether this effect is in fact obtained will depend on the pH of the beverage. When the pH of the beverage is such that said pathogenic bacteria are not active, the present invention will not further suppress the growth of bacteria, and the present invention will not increase the microbiological food safety of the product, but only extend the shelf life by decreasing the activity of fungi, including yeasts, in the product. When the beverage has a pH where bacteria are active, the presence of an antimicrobial gas in accordance with the invention will decrease the activity of said bacteria, resulting in an improved microbiological food safety of the product.

The use of an antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O has the advantage that these gases combine a high microbiological activity with good food-compatibility. More in particular, in the concentrations in which these gases are used in accordance with the present invention they are not detrimental to the health of the user of the liquid. Neither do they detrimentally affect the organoleptic properties of the beverage to a substantial extent.

While in principle the use of one or more of CO, NO, NO₂, and N₂O may be combined with the use of other antimicrobial gases, it may be preferred for the beverage not to comprise other gases which substantial antimicrobial activity. Accordingly, in one embodiment of the present invention the antimicrobial gas consists substantially of one or more of CO, NO, NO₂, and N₂O.

In another embodiment of the present invention the use of one or more of CO, NO, NO₂, and N₂O is combined with the use of CO₂. This combination has the advantage that the amount of one or more of CO, NO, NO₂, and N₂O may be reduced. The combination of CO₂ with CO may be a particularly preferred embodiment of the present invention.

In one embodiment the beverage does not contain substantial amounts of oxygen. In one embodiment, it may be preferred if the oxygen concentration in the beverage is so low that the growth of aerobic bacteria is substantially suppressed. It is within the scope of the skilled person to determine an adequate oxygen content in this respect.

The amount of gas to be used in the beverage according to the invention varies between 0.01 ppm and 0.1 wt.%. It is noted that the amount of gas used in the beverage is so low that it does not generate the fizzyness known from fizzy drinks. In most cases the amount of added gas is so low that it will not substantially generate or increase a fizzy mouth feel in the beverage.

In particular, at least 1 ppm of gas will be used, more specifically at least 5 ppm, still more in particular at least 10 ppm.

The maximum amount of gas used in the present invention is in particular at most 500 ppm, still more in particular at most 200 ppm, even more in particular at most 100 ppm.

There are a number of parameters influencing the amount of gas to be used, and with the guidelines given below it is well within the scope of the skilled person to determine the appropriate amount of gas for a specific situation.

The antimicrobial activity of the gas is of influence here. In particular, the higher the antimicrobial activity, the less gas is needed to obtain a particular shelf life or microbial food safety value. The higher the desired increase in shelf life or microbiological food safety of the product, the more gas will be used. The gas is particularly useful against fungi, including yeasts. As the activity of these organisms increases with higher pH value, a higher pH value may lead to the use of a larger amount of gas.

The invention can be used in any desired beverage for human or animal consumption. In particular, beverages can comprise one or more components selected from natural or artificial sweeteners, fruit-, grain-, or vegetable-components or derivatives thereof, tea, coffee, or herbs, or derivatives thereof, natural or artificial vitamins, dairy components, natural or artificial acidic components, mineral water, and alcohol.

Suitable beverages include lemonades, fruit or vegetable juices, other soft drinks, including soft drinks based on tea, coffee, or herbs, dairy-based beverages, beverages based on grain such as wheat or rice, soy-based beverages, beer, wine, spirits, liquors, and mineral water. As indicated above, the present invention is applicable both to ready-to-drink beverages and to beverage intermediates which will be converted to ready-to-drink beverages by the addition of water and optional other components. Within the context of the present specification the word beverage encompasses both these embodiments, unless the contrary is clear from the context.

Examples of beverage intermediates for which the present invention is particularly suitable are concentrates and syrups, in particular juice concentrates, which are often transported over long distances.

The invention finds application in beverages of any pH, in particular a pH in the range of 2.5 to 7.5.

The present invention finds application in beverages with a pH of 2.5 up to 4.6 for increasing the shelf life thereof. At these low pH values bacterial activity is relatively limited and the invention is primary directed to increasing the shelf life of the product by prevention of the growth of fungi, including yeasts.

The present invention also finds particular application in beverages with a pH of 4.6 to 7.5. At these higher pH

values the present invention decreases the activity of fungi, including yeasts, leading to increased shelf life of the product. Additionally, the present invention may additionally decrease the activity of bacteria in the beverage, including
5 pathogenic bacteria, resulting is an increased microbiological safety of the product.

The invention finds application in carbonated and uncarbonated beverages. Use in uncarbonated beverages may be preferred.

10 In carbonated beverages CO₂ is generally present in an amount of above 0.3 wt.%. The benefit of the present invention in carbonated beverages resides in the provision of additional antimicrobial protection by the addition of a food-compatible antimicrobial gas in the specified amounts.

15 As indicated above, the present invention also pertains to a method for improving the microbiological food safety of beverages for animal or human consumption, wherein 0.01 ppm to 0.1 wt.% of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O is added to the beverage, after
20 which the liquid is sealed in a gas-impermeable container. The method of adding the gas to the beverage is not critical to the present invention. Suitable methods are known to the skilled person and include dissolving gas in the product at low temperature under pressure and packaging the product
25 before the gas escapes. Suitable further methods for adding the gas include contacting the beverage with an atmosphere containing the antimicrobial gas, optionally in combination with other gases. Other gases may be air, or inert gases like nitrogen. It is also possible to spargle the gas through the
30 beverage using methods known in the art.

It has been found that the addition of noble gases like argon, xenon, neon, and krypton does not improve the effect of the present invention. As the presence of these gases will contribute to the packaging costs, it is preferred for the

beverage according to the invention to be substantially free from added argon, xenon, neon, or krypton. This means that in this embodiment these gases are not added on purpose. If they are present, they are only present as contaminants in other gases used in the present invention, such as air.

The invention also pertains to the use of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O in an amount of 0.01 ppm to 0.1 wt.% to improve the shelf life and where appropriate the microbiological food safety of beverages for animal or human consumption. The present invention also pertains to the use of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O in an amount of 0.01 ppm to 0.1 wt.% in increasing the resistance of beverages for animal or human consumption against the growth of fungi, including yeasts, and optionally against the growth of bacteria. For further details on method and use, reference is made to what has been stipulated above for the beverage itself.

CLAIMS

1. Beverage for animal or human consumption comprising 0.01 ppm to 0.1 wt.% of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O.

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2. Beverage according to claim 1, which comprises one or more components selected from natural or artificial sweeteners, fruit-, grain-, or vegetable-components or derivatives thereof, tea, coffee, or herbs, or derivatives thereof, natural or artificial vitamins, dairy components, natural or artificial acidic components, mineral water, and alcohol.

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3. Beverage according to claim 1 or 2, which selected from lemonades, fruit or vegetable juices, soft drinks, including soft drinks based on tea, coffee, or herbs, dairy-based beverages, beverages based on grain such as wheat or rice, soy-based beverages, beer, wine, spirits, liquors, and mineral water.

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4. Beverage according to any one of the preceding claims wherein the gas is present in an amount of up to 500 ppm, in particular up to 200 ppm, more in particular up to 100 ppm, the gas being present in an amount of at least 1 ppm, in particular at least 5 ppm, more in particular at least 10 ppm.

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5. Beverage according to any one of the preceding claims which has a pH in the range of 2.5 to 7.5.

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6. Beverage according to claim 5, which has a pH of 2.5 up to 4.6.

7. Beverage according to claim 5, which has a pH of 4.6 to 7.5.

8. Beverage according to any one of the preceding claims which is a ready-to-drink beverage.

9. Beverage according to any one of the preceding claims 1-7 which is a beverage intermediate which will be converted to a ready-to-drink beverage by the addition of water and optional other components.

10. Method for improving the shelf life of beverages for animal or human consumption wherein 0.01 ppm to 0.1 wt.% of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O is added to the beverage, after which the beverage is sealed in a gas-impermeable container.

11. Use of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O in an amount of 0.01 ppm to 0.1 wt.% to improve the microbiological food safety of beverages for animal or human consumption.

12. Use of a food-compatible antimicrobial gas comprising one or more of CO, NO, NO₂, and N₂O in an amount of 0.01 ppm to 0.1 wt.% in increasing the resistance of beverages for animal or human consumption against the growth of fungi, including yeasts.