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(54) Title: BEVERAGE COMPRISING INSOLUBLE GAS

(57) Abstract: The present invention relates to the use of insoluble gas in beverage to improve head characteristics and to pro¬ vide a more pleasant and smooth mouth feeling experience perceived by the drinker.

Beverage comprising insoluble gas

Field of the Invention

The present invention relates to the use of insoluble gas in a beverage, such as a beer or soft drink.

Background Art

Very traditional bubbling, fizzy effervescent drinks are generically known as carbonated beverages. Where the term "carbonated" refers to carbon dioxide being dissolved in the drink. In general, the drinks principal ingredient is water and part of the carbon dioxide reacts with the water and forms carbonic acid, the remainder of the carbon dioxide stays in physical solution. The carbon dioxide is often by means of pressurized packaging not in equilibrium with ambient pressure, 101,335 Pa, not even if served at quite low temperature, like zero degrees.

When the package is opened by the consumer the pressure in the headspace of the package is suddenly insufficient to keep the carbon dioxide in solution, and it begins to evade. However, this is a slow process that takes tens of minutes, so the drinker will experience in his mouth a special astringent, tickling feeling when carbon dioxide bubbles escape the thin liquid layer in the lower jaw around the tongue. The carbonic acid contributes a distinct sharp acidic pungent taste. The bursting carbon dioxide bubbles, when bursting, produces a fine aerosol mist, which purveys notes to the olfactory organ in the nose, and, thus, also contributes to the smell.

It is probably this "freshness", which throughout millennia has enchanted people. Natural sparkling waters and fermented sparkling beverages like beer and

Champagne has always been at a premium. However, the carbon dioxide can fill out one more function: It is often wanted, particularly on beer, to serve it with a nice head of broth, and often the quality of the broth has to be so, that a little of it lasts till the end of the drinking session.

The head stems from rising carbon dioxide bubbles, which must originate from some imperfection in the glass used for serving, or from particles suspended in the liquid. They rise to the surface faster than one would think from Stokes law, because they, due to the reducing hydrostatic pressure expand while rising, and because of growth/feeding/diffusion of the bubble due to diffusion into the bubble from the surrounding liquid. When they break the surface, they carry on the upper dome a layer of the liquid. If the bubbles rise sufficiently fast one bubble will ride on a layer of other bubbles, and we have formed a broth. Initially, this broth consists of spherical bubbles with a viscous layer of liquid taking up the void volume. If one tilts the glass, the head will maintain a horizontal surface, like the drink below it. This is so because the void volume of liquid obeys Poiseuilles equation. After a while, however, the liquid drains and the bubbles will start to touch, and have polyhedral platelets with a very thin liquid layer in between them. Soon all bubbles will be polyhedral. The most probable polyhedron, a non-Euler polyhedron, is one composed of hexagons and pentagons. The head is now solid, the movement of the liquid between the facets of the platelets now being controlled by capillary flow.

Apart from the aesthetic appeal of the head broth, it, also, serves to protect the reducing notes, for instance alfa-iso humolonic acid in beer or aldehydes or

terpineols in soft drinks, of the beers entire taste profile against attack from atmospheric oxygen. For this purpose, it is a lucky coincidence that carbon dioxide is almost 50% heavier than the ambient atmosphere, so that it stays on top of the head broth as a water vapour saturated lid, protecting the head from drying out.

The lifetime of the head can vary from seconds to hours dependent on viscosity and initial bubble size. For many types of drinks, it is desirable to increase this lifetime. One way of increasing the head's life is simply to increase the amount of dissolved carbon dioxide. Henry's law is to a certain extent applicable for such beverages.

A more viscous foam can be created by adding various polymers or directing the fermentation in a way, that generates those. They are often polysaccharides. It is also known that addition of hexa-hydro-alfa-iso humolonic acid creates a very stable head.

Another way of increasing the head's life is by dissolving a further soluble gas, like nitrous oxide (N_2O), in the beverage in addition to carbon dioxide, which increases the total amount of dissolved gas.

US 2002/0197364 discloses a method of producing a liquid product packed in cans or bottles or other suitable containers. The method includes injection of one or more of nitrogen, carbon dioxide and nitrous oxide gas into the liquid product.

WO 00/23357 describes a method of improving the foaming characteristics of a nitrogenated liquid product packaged into cans, bottles or other suitable containers by shaking. In addition, it discloses a method characterised by injection of nitrous oxide and, optionally, nitrogen and/or carbon dioxide into the liquid product

prior to, during or after filling the liquid product into cans or bottles or other suitable containers.

In addition, Nitrogen has been used for nitrogenized Stout beer throughout the world since many years to obtain a creamy head. However, certain measures are necessary to obtain a convincing creamy head with Nitrogen.

Guinness and Caffries use the so-called widget technology, where a Nitrogen-filled widget of plastic with a small hole generates a lot of small bubbles, when the pressure falls, that create the creamy head.

Another way of creating a creamy head in nitrogenized beer is by using the so-called SURGER sold by Guinness, which creates the creamy head by using ultrasound.

Use of argon and hydrogen in beverage is known but with other purposes than improving head characteristics.

GB1408995 discloses a method of dissolving inert gas like Nitrogen, Argon and Hydrogen in a beverage, such as beer, wine and soft drinks, which comprises removal of air from a container, introduction of inert gas into the container and filling of the container with the beverage so that the gas pressure within the container is in the range of 5 to 90 psig. The purpose of which is to improve taste and resistance to deterioration.

However, it is a constant challenge within the field of effervescent beverages to provide beverages with a long-lasting head without affecting the taste of the beverage in a negative manner. It is, also, a challenge to provide an effervescent beverage wherein the dissolved gas or gasses contribute to give the drinker a pleasant feeling in the mouth while drinking the beverage.

Although a large number of effervescent beverages are currently known in the art, there is still an unmet need for providing an improved beverage, which gives the drinker a more pleasant mouth feeling experience when drinking the beverage. There is, also, a need for providing a beverage, which can generate a more stable head when poured. There is a further need for providing an improved beverage with the mentioned properties, in which the achievement of those properties does not add greatly to the cost of producing the beverage.

Summary of the Invention

The present invention relates to the use of insoluble gas in a beverage to improve the head characteristics and to provide a more pleasant and smooth mouth feeling experience.

This effect can be obtained by dissolving one or more of the following insoluble gases: cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Nitrogen, Hydrogen, Neon and/or Helium with the proviso that Nitrogen is not the only insoluble gas. Preferably, the beverage further comprises one or more soluble gases like N_2O and CO_2 in the beverage.

Accordingly, in one aspect, the present invention provides the use of insoluble gas for improving head characteristics of a beverage, with the proviso that N_2 is not the only insoluble gas used.

In a preferred embodiment, the use of the insoluble gas with a solubility of less than 1.0 g/l at room temperature and ambient pressure is provided.

In a second preferred embodiment, the use of the insoluble gas, which is selected from cyclic hydrocarbons,

Krypton, propane, ethane, methane, Argon, Oxygen, Hydrogen, Neon and Helium is provided.

In a third preferred embodiment, the use of insoluble gas in beverage in an amount of around 0.1 g/l to around 2 g/l, preferably around 0.3 g/l to around 1 g/l, is provided.

In another preferred embodiment, the said beverage is a beer or soft drink.

In a further preferred embodiment, the use of N_2O in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l, is provided.

In another preferred embodiment, the use of CO_2 in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l, is provided.

In still another preferred embodiment, the use of N_2 is further provided.

In a second aspect, the present invention provides a beverage with improved head characteristics, which comprises N_2O and an insoluble gas, with the proviso that N_2 is not the only insoluble gas comprised in the beverage.

In a preferred embodiment the beverage comprising the insoluble gas with a solubility of less than 1.0 g/l at room temperature and ambient pressure is provided.

In a second preferred embodiment, the beverage, which comprises insoluble gas selected from cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Hydrogen, Neon and Helium, is provided.

In a third preferred embodiment, the beverage is a beer or soft drink.

In another preferred embodiment, the beverage, which comprises N_2O in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l, is provided.

In a further preferred embodiment, the beverage, which comprises the insoluble gas in an amount of around 0.1 g/l to around 2 g/l, preferably around 0.3 g/l to around 1 g/l, is provided.

In another preferred embodiment, the beverage, which, furthermore, comprises CO_2 in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l, is provided.

In still another preferred embodiment, the beverage, which further comprises N_2, is provided.

Detailed description of the invention

An object of the present invention is to wholly or partly address the above mentioned unmet needs. More specifically, it is an object to provide a beverage, which confers an improved mouth feeling experience when being drunk by a consumer. It is, also, an object of the present invention to provide a beverage with a longer lasting head. It is, furthermore, an object of the present invention to provide a beverage with the mentioned properties, which is not difficult or expensive to produce when compared to traditional beverages.

The above objects together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a beverage, such as a beer or soft drink, comprising an insoluble gas with the proviso that Nitrogen is not the only insoluble gas. Preferably, the beverage further comprises a soluble gas, like N_2O and CO_2.

Preferably, said beverage comprises one or more of the following insoluble gases: cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Nitrogen,

Hydrogen, Neon and/or Helium with the proviso that Nitrogen is not the only insoluble gas. Most preferred, the beverage further comprises one or more soluble gases like N_2O and CO_2.

Preferably, said beverage is a beer. However, the present invention is not restricted to beer. Instead, the use of insoluble gas and certain other gases like N_2O for both beer, and non-beer, such as mineral water, flavoured alcoholic beverages, malt drinks and the like is provided. Preferably, N_2O can be used for certain beverage types, where the distinct advantages on the quality of head disclosed above as well as the sweet taste can be of particular advantage. Such types of beverage include i.a. top fermented beers and bottom fermented beers. Specifically, the beer types included are Wit, Weizen, Dunkelweizen or Ale types, such as Paleblond, Brown, Bitter IPA or Barley wines and Stouts. The bottom fermented types includes the American light beer lagers, Vienna type beers, Märzen and Red Beers or typical Münich types, Dark Münich and Bock, and finally the Baltic Porter types. In all instances the insoluble gas and, preferably, N_2O dissolved in beverage imparts a smooth and pleasant mouth feel and provides a pleasant stable head.

Preferably, the beverage comprises the insoluble gas in an amount of around 0.01 g/l to around 5 g/l. More preferred, the beverage comprises the insoluble gas in an amount of around 0.1 g/l to around 2 g/l. Even more preferred, the beverage comprises the insoluble gas in an amount of around 0.3 g/l to around 1 g/l.

In addition, the beverage, preferably, comprises N_2O in an amount of around 0.1 g/l to around 15 g/l. More preferred, the beverage comprises N_2O in an amount of around 1 g/l to around 10 g/l. Even more preferred, the

beverage comprises N_2O in an amount of around 4 g/l to around 6 g/l.

Furthermore, the beverage, preferably, comprises CO_2 in an amount of around 0.1 g/l to around 15 g/l. More preferred, the beverage comprises CO_2 in an amount of around 1 g/l to around 10 g/l. Even more preferred, the beverage comprises CO_2 in an amount of around 4 g/l to around 6 g/l.

The matter is that smaller bubbles will generate a longer lasting head. There is, however, a physical limit to how small bubbles that can be formed in such a carbon dioxide/water system, and this physical limit depends on the surface tension. Specifically, if a hypothetical bubble is smaller than 2*(surface tension of the liquid)/P, where P is the pressure in Newton/m^2 that the bubble "sees", it will collapse and be reabsorbed into the liquid. Thus, the lower the surface tension, the smaller the bubble.

It is known from surface chemistry that high surface tension and high solubility goes together. This is so because a molecule of high solubility to a lesser extent is expelled to the surface.

By adding a small amount of a much more insoluble gas than carbon dioxide, this gas will, when the equilibrium pressure is suddenly reduced lead to spontaneous formation of much smaller bubbles.

The inventors have found that in normal carbonised beverages the initial bubble size is around 40 micron in diameter, but by adding a heavily insoluble gas in the amount of 0.3 g/l to 1 g/l the size of the seedling bubbles decreases by 3 orders of magnitude and the number of seedling bubbles increases by a similar figure.

We have discovered that smaller bubbles created by dissolving insoluble gas in beverage provides a more stable and longer lasting head that does not affect the taste of the beverage. In fact, the above-mentioned beverage with dissolved insoluble gas imparts a more viscous and delicious creamy head that contributes positively to the overall pleasant mouth feeling experience as well as the visual appearance of the said beverage perceived by the drinker.

Thus, according to the present invention, the discovery provides a solution to the mentioned challenge of improving head characteristics and the mouth feeling experience of an effervescent beverage without affecting the cost significantly.

Based on this discovery, according to the present invention several insoluble gases can be used to provide a beverage with the said improved head characteristics.

Insoluble gases according to the present invention are gases with a solubility of less than 1.0 g/l, preferably less than 0.5 g/l, and most preferred less than 0.1 g/l at room temperature and ambient pressure.

An insoluble gas according to the present invention is selected from the group consisting of: cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Nitrogen, Hydrogen, Neon and Helium. The insolubility increases from left to right.

Argon is easily available in liquid form or as compressed gas. Since it is extracted by distillation of the atmosphere, of which it constitutes 0.9%, it is abundant, inert, environmentally perfectly inert, non-toxic (as it forms no chemical compounds), and safe.

Oxygen is easily available and quite inexpensive because of its high abundance; it constitutes 20.9 % of the atmosphere and is extracted by distillation like Argon.

Hydrogen can be used in amounts and concentrations far from the explosion limits and is deemed safe as well.

Helium is, also, an efficient gas for this application.

We have, furthermore, discovered that the use of insoluble gas combined with N_2O in a beverage enhances the head characteristics and the mouth feeling experience even more without the need for the further measures mentioned in "Background Art" regarding Nitrogen. Nitrous oxide not only contributes to form a more creamy and stable delicious head, but it, also, provides the beverage with a pleasant sweet taste.

There is, however, one more way to improve the head of the drink. Carbon dioxide is a triatomic linear molecule, which due to the symmetry O=C=O has no dipolar momentum, and thus is physically very soluble in water. However, carbon dioxide reacts with water and forms carbonic acid and is, thus, only partially dissolved as a physical solution. The carbonic acid formation equilibrium could be driven backward by lowering the pH value of the beverage by means of adding a stronger acid. But soon the acid taste becomes objectionable. One could contemplate to use other gases such as HFC and HCFCs. Even ethene with its distinct apple smell and taste could be used in for instance a cider product. But these gases are greenhouse gases, and can induce nausea and euphoria. They are, however, in widespread use in air-condition gear, fridges and aerosol cans.

Instead, as mentioned above, the present invention provides the use of one or more insoluble gases alone or in combination with nitrous oxide and/or carbon dioxide, where the insoluble gas is selected from cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Nitrogen, Hydrogen, Neon and Helium with the proviso that Nitrogen is not the only insoluble gas.

Nitrous oxide is a linear molecule, but not symmetrical. The structure is N=N=O. The electron structure can only be explained with the use of orbital theory. It has a high dipolar momentum, and its dissolution into water is by a quite different mechanism than that of carbon dioxide. But apart from this, the similarities between N_2O and CO_2 are many: The two have almost the same melting Point, are isomorphous, can co-crystallize in all ratios, have similar boiling points (-89°C and -79°C respectively) for N_2O and CO_2, they can be kept as liquids at room temperature at some 80 bar, they both have the molecular weight 44, and they have similar solubility in water. According to J. Chem. Eng. Data 1995,40,627-629 their Henry's law constants and diffusion constants in the range 303K to 333K are parallel within 5%. This is surprising because the dissolution mechanisms are so very different, one being by chemical reaction, the other being purely physical. In so far as nitrous acid is not formed by dissolution in water, but has to be prepared by a detour. In nature, N_2O is formed by certain bacteria. Artificially, it is made by either heating ammonium nitrate to 190°C or, according to Ullmann, by a new process with direct reaction of nitric acid and ammonia. According to Gmelin it is endothermic, but can, unlike acetylene, only with great difficulty be brought to detonation

by means of a strong detonator, and then only at high temperature.

Examples/Preferred Embodiments

The following experiment illustrates the present invention without limiting the scope of the invention:

In the experiment, 17 l of a 50 l keg of fresh Carlsberg Pilsner at 5°C is discarded, the keg is shaken, left for 2 hours so that the head is allowed to settle and is ventilated to the atmosphere, it is then shaken again, left and ventilated, etc. After 6 shakings, the content of the keg is completely "flat". A water trap is continuously used to maintain sterility. The keg is always kept in the cold store at 5°C.

Then, the keg is connected to a cylinder of Helium and a cylinder of N_2O. The reduction valve at both cylinders is manipulated to 3 bar, the beer is shaken, and the keg sealed off.

The next day, the Helium/N_2O/CO_2 mixture is ventilated to the atmosphere, and the procedure is repeated. After 4 days the pressure of Helium and N_2O will not drop measurable over night.

A further pressure settling is performed the following day, and 3 days later the pressure will remain unchanged at 3 bar.

The beer is, then, cold stored and tapped aseptically in common 33 cl bottles on a laboratory filling machine. After one week the beer is poured normally into test glasses. The resulting beer will have the creamy head and the clear sweet taste, and will miss the "pricking" from carbon dioxide.

The shaking off beer as described above normally leads to denaturation of certain proteins that are nor-

mally considered to contribute to creation of the head. Without being bound by theory this is believed to be the result of the shaking of beer, probably heavily assisted by CO_2. Such denatured proteins are very characteristic in a phase contrast microscope as skin. This phenomenon will not appear at all when using the described procedure, whereas a shaken control keg with all the CO_2 shows skin already after one day.

Although the invention above has been described in connection with an example of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims:

1. Use of insoluble gas for improving head characteristics of a beverage, with the proviso that N_2 is not the only insoluble gas used.

2. Use according to claim 1, wherein the solubility of the insoluble gas is less than 1.0 g/l at room temperature and ambient pressure.

3. Use according to claim 1 or 2, wherein the said insoluble gas is selected from cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Hydrogen, Neon and Helium.

4. Use according to any of the preceding claims, wherein said beverage comprises the insoluble gas in an amount of around 0.1 g/l to around 2 g/l, preferably around 0.3 g/l to around 1 g/l.

5. Use according to any of the preceding claims, wherein said beverage is a beer or soft drink.

6. Use according to any of the preceding claims, which further comprises N_2O in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l.

7. Use according to any of the preceding claims, which further comprises CO_2 in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l.

8. Use according to any of the preceding claims, which further comprises N_2.

9. A beverage with improved head characteristics, which comprises N_2O and an insoluble gas, with the proviso that N2 is not the only insoluble gas comprised in the beverage.

10. A beverage according to claim 9, wherein the solubility of the insoluble gas is less than 1.0 g/l at room temperature and ambient pressure.

11. A beverage according to claim 9 or 10, wherein the said insoluble gas is selected from cyclic hydrocarbons, Krypton, propane, ethane, methane, Argon, Oxygen, Hydrogen, Neon and Helium.

12. A beverage according to any of the claims 9 to 11, which is a beer or soft drink.

13. A beverage according to any of the claims 9 to 12, wherein said beverage comprises N_2O in an amount of around 0.1 g/l to around 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l.

14. A beverage according to any of the claims 9 to 13, wherein said beverage comprises an insoluble gas in an amount of around 0.1 g/l to around 2 g/l, preferably around 0.3 g/l to around 1 g/l.

15. A beverage according to any of the claims 9 to 14, which further comprises CO_2 in an amount of around 0.1 g/l to 15 g/l, preferably around 1 g/l to around 10 g/l, and especially preferred around 4 g/l to around 6 g/l.

16. A beverage according to any of the claims 9 to 15, which further comprises N_2.