

A METHOD OF PRODUCING A BEVERAGE

TECHNICAL FIELD

[0001] This invention generally relates to a method for the production of a fruit and/or vegetable beverage. In particular, the beverage can comprise substantially the entire edible part of the fruit and/or vegetable (including the peel when appropriate), and therefore retain the nutritional benefit of substantially the entire fruit and/or vegetable.

BACKGROUND ART

[0002] Fruit juice has been consumed for centuries as a healthy, refreshing, and enjoyable beverage. Juice is made from the extraction or pressing of the natural liquid contained in fruit. By extracting the liquid from a fruit, but leaving behind the solid components of the fruit, a product is made that is of low enough viscosity to be easy to consume as a beverage. However, by its nature a juice is low in fibre, and many of the nutrients remain in the pomace (the solids remaining after pressing the juice from the fruit). That is, much of the nutritional content of the whole fruit is discarded, so that the juice contains only a fraction of the original nutritional benefit. This is also true for some vegetable-based beverages.

[0003] A smoothie is a drink made from pureed raw fruit and/or vegetable, typically using a blender. However, this alone results in a higher viscosity puree that cannot be readily consumed as a beverage. Therefore, to produce a lower-viscosity beverage, a smoothie often has a liquid base/diluent such as water, fruit juice, or milk (or milk products). Smoothies may include other ingredients such as crushed ice, sweeteners, herbal supplements, or nutritional supplements. That is, while a smoothie can have a higher / more diverse nutrition content than a juice, the nutrition is diluted by addition of the liquid base/diluent, and/or enhanced by other supplements.

[0004] Accordingly, it would be advantageous to provide a fruit and/or vegetable beverage that can deliver the nutritional benefits substantially of, or closer to, the whole fruit and/or whole vegetable.

SUMMARY OF INVENTION

[0005] In one aspect, the present invention is directed to a method of producing a fruit and/or vegetable beverage which includes substantially the whole edible part of the fruit and/or

vegetable, including the peel when appropriate, and therefore retains the nutritional benefit of substantially the whole edible part of fruit and/or vegetable.

[0006] In another aspect, the present invention is directed to a method for preparing a nutritious beverage substantially from the whole edible part of a fruit and/or the whole edible part of a vegetable that achieves sufficiently low viscosity so as to be pleasant to drink.

[0007] In yet another aspect, the present invention is directed to a nutritious beverage substantially based on the edible part of whole fruit and/or the edible part of whole vegetable that achieves sufficiently low viscosity so as to be pleasant to drink.

[0008] According to a first embodiment of the present invention, there is provided a method of preparing a beverage substantially from the whole edible part of fruit and/or vegetable, the method comprising the steps of:

- optionally, a preparation step for preparing the fruit and/or vegetable, to thereby produce a prepared fruit and/or vegetable;

- optionally, a non-edible part removal step for removing any non-edible part of the fruit and/or vegetable;

- a pulping step for substantially pulping the fruit and/or vegetable or edible part thereof, to thereby produce fruit and/or vegetable pulp;

- an extraction step for extracting juice from the fruit and/or vegetable pulp;

- optionally, at least one spoilage prevention step for preventing or reducing spoilage;

- a pulp liquefaction step for liquefaction of the fruit and/or vegetable pulp;

- at least one homogenisation step for homogenising fruit and/or vegetable pulp and the juice to produce a beverage homogenate; and

- a beverage preparation step comprising preparing a beverage from the beverage homogenate, wherein said beverage contains substantially the entire edible part of whole fruit and/or vegetable and is pourable.

[0009] Any suitable type of fruit or any combination of different types of fruits can be used,

such as pome fruit, citrus or berry. Suitable examples may include an apple, orange, lemon, lime, pear, peach, pineapple, quince, apricot, plum, cherry, strawberry, blackberry, raspberry, mango or grape. In some embodiments, the fruit can be a member of the plant family *Rosaceae*. In particular, the fruit can be one or more types of a pome fruit. For example, an apple, pear, nashi, loquat or quince can be used.

[0010] Typically, many pieces of fruit will be used in the method, depending on the quantity of beverage required.

[0011] Any suitable type of vegetable or any combination of different types of vegetables can be used. Suitable examples may include beetroot, celery, cucumber, cabbage, spinach, broccoli, tomato or carrot.

[0012] Typically, much vegetable produce will be used in the method, depending on the quantity of beverage required.

[0013] Any suitable combination of different types of fruits and/or vegetables can be used.

[0014] In some embodiments, the method can comprise a preparation step for preparing the fruit and/or vegetable to thereby produce prepared fruit and/or vegetable, and this can be achieved in any suitable way. In some embodiments, the preparation step comprises washing the fruit and/or vegetable to produce washed fruit and/or vegetable. In some embodiments, the preparation step comprises sanitising the fruit and/or vegetable to produce a sanitised fruit and/or vegetable. For example, washing the fruit and/or vegetable can involve washing the fruit and/or vegetable in a stream of fresh water, with or without a mild detergent. For example, sanitising the fruit and/or vegetable can involve bathing, rinsing or spraying the fruit and/or vegetable in or with a mild solution of sanitiser such as peracetic acid or chlorine (e.g. sodium hypochlorite) to minimise bacteria.

[0015] The method can comprise a non-edible part removal step for removing any non-edible part of the fruit and/or vegetable, such as the stem/core or seed, to produce an entirely edible pulp. For a pome fruit, in some embodiments, the core and therefore the seeds can be removed. In some embodiments, the core and/or the seeds can be retained and form part of the beverage.

[0016] The non-edible part removal step can be carried out in any suitable way. The non-edible part removal step can be carried out prior to the pulping step, during the pulping step, or after the pulping step.

[0017] Preferably for a pome fruit the skin and/or peel is retained as it increases the nutrient value.

[0018] The method can comprise at least one pulping step for pulping substantially the entire fruit and/or vegetable, or edible part thereof. Pulping can be carried out in any suitable way to produce fruit and/or vegetable pulp. In some embodiments, a pulper machine is used.

[0019] In some embodiments the method can comprise a non-edible part removal step for removing any non-edible part of a first fruit and/or vegetable batch, to thereby produce a first processed fruit and/or vegetable batch. In some embodiments the method can comprise a pulping step for substantially pulping the first processed fruit and/or vegetable batch, to thereby produce a first processed fruit and/or vegetable pulp.

[0020] In some embodiments the method can comprise a pulping step for substantially pulping a second whole fruit and/or vegetable batch with non-edible parts left in, to thereby produce a second whole fruit and/or vegetable pulp.

[0021] The method can comprise a juice extraction step, to thereby produce fruit and/or vegetable juice. Juice extraction can be carried out in any suitable way to produce juice. The juice extraction step can comprise, for example, squeezing juice from the fruit and/or vegetable pulp. In other embodiments, centrifugation or counter-current extraction can be used.

[0022] In some embodiments the method can comprise an extraction step for extracting juice from the second whole fruit and/or vegetable pulp.

[0023] In some embodiments, the method can comprise a spoilage prevention step for preventing or reducing spoilage of the fruit and/or vegetable pulp and/or juice. In some embodiments, the spoilage prevention step can be carried out by conducting the method in an air- or oxygen-free or reduced environment. In some embodiments, the spoilage prevention step can comprise reducing oxidation of the fruit and/or vegetable pulp and/or juice by adding at least one antioxidant and/or preservative to the pulp and/or juice to prevent or reduce degradation. In some embodiments, an antioxidant such as ascorbic acid can be added to reduce

colour degradation. Any suitable amount of antioxidant can be used. For example, anywhere between about 0% weight/weight to about 1% weight/weight antioxidant or more (e.g. ascorbic acid) can be used, including all 0.01 increments between 0 and 1, including 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10%, etc. In some embodiments, about 0.05 to 0.15% weight/weight antioxidant (e.g. ascorbic acid) is used, including all 0.01 increments between 0.05 and 0.15, including 0.06, 0.07, 0.08, 0.09, 0.10%, etc. In some embodiments, about 0.1% weight/weight antioxidant (e.g. ascorbic acid) is used.

[0024] An antioxidant and/or preservative can be added prior to, during or after the pulping step. The antioxidant and/or preservative can be added prior to, during or after the juice extraction step. The antioxidant and/or preservative can be added prior to, during or after the homogenisation step.

[0025] Preferably, where the fruit is a pome fruit, such as an apple, about 0.1% weight/weight antioxidant (e.g. ascorbic acid) is used.

[0026] The spoilage prevention step can be carried out at any stage of the method. For example, an antioxidant and/or preservative can be added before, during or after one or more homogenisation steps, or when pasteurising.

[0027] The method can comprise a mixing step for mixing the pulp and extracted juice together. This can be carried out in any suitable way.

[0028] In some embodiments, the method can comprise a mixing step for mixing extracted juice with fruit and/or vegetable pulp, to produce a juice-pulp mixture. This can be achieved in any suitable way. In some embodiments the method can comprise a step of mixing the juice extracted from the second whole fruit and/or vegetable pulp with the first processed fruit and/or vegetable pulp, to produce a juice-pulp mixture.

[0029] The method can comprise a pulp liquefaction step for liquefaction of the pulp or juice-pulp mixture. This can be carried out in any suitable way. More than one pulp liquefaction step can be carried out. In some embodiments, the pulp liquefaction step involves subjecting the pulp to one or more macerating enzymes that act, for example, on soluble pectin and on cell wall components. The pulp liquefaction step can assist in lowering viscosity and maintenance of texture. Suitable macerating enzymes may include, but are not limited to, pectinase, amylase, cellulase, hemicellulose, pectolyase, pectozyme and polygalacturonase. Addition of a macerating

enzyme to the pulp can increase the release of phenolic and other nutritionally important components. Macerating enzymes can break down components (e.g. pectin in fruit) that otherwise causes the pulp to be too viscous to be drinkable as a pleasant beverage.

[0030] In some embodiments, the method can comprise at least one pulp liquefaction step for liquefaction of the pulp or juice-pulp mixture.

[0031] The beverage's ingredient content can be tailored for the particular type of fruit and/or vegetable used. For example, some types of fruit may have a higher starch content and require a different amount and/or type of enzyme in order to achieve the required viscosity.

[0032] In some embodiments, the macerating enzyme is a pectinase enzyme. Any suitable amount of a pectinase enzyme can be used. For example, anywhere between about 10 ppm to about 1000 ppm enzyme can be used, including all 5 ppm increments between 10 and 1000, including 25 ppm, 30 ppm etc. In some embodiments, about 100 ppm of a pectinase enzyme is used for a pome fruit extract.

[0033] In some embodiments, a macerating enzyme can be added before, during or after one or more homogenisation steps.

[0034] In some embodiments, the step of pulp liquefaction involves subjecting the pulp or juice-pulp mixture to one or more macerating enzymes at an appropriate temperature for an appropriate time, to optimise enzymatic action. There are virtually infinite options for the hold temperature and hold time for this step. That is, the higher the temperature, the less time required – as long as the temperature is not so high as to inactivate the enzyme. The step of pulp liquefaction could be done at room temperature but would take a lot longer. Preferably, the step of pulp liquefaction is carried out at approximately 55°C for about 30 minutes. This particular temperature is high enough to optimise enzymatic action without inactivating the enzyme or causing excessive discolouration of the juice. This temperature is also high enough to be beyond the growth range for some significant microbes.

[0035] The method can comprise a juice modification step for modifying one or more properties of the extracted juice, to produce a modified extracted juice. This can be carried out in any suitable way. In some embodiments, one or more modifying enzymes are used, for example, for debittering of citrus fruit juice or preventing darkening of juice.

[0036] The method can comprise at least one homogenisation step for homogenising the pulp and the juice (juice-pulp mixture). This can be carried out in any suitable way. In some embodiments, a high-shear mixer is used for mixing, emulsifying and homogenising. A suitable example of a high-shear mixer is a Silverson™ high-shear mixer.

[0037] The method can comprise a first homogenisation step for breaking down initial particle size of the pulp (and/or juice, if relevant) so that the pulp liquefaction (liquefaction) step is more effective.

[0038] The method can comprise a second homogenisation step for reducing the particles to a fine enough size to reduce viscosity, such that the beverage or beverage homogenate is pourable and preferably provides a smooth mouthfeel, and preferably prevents significant separation of the beverage during storage.

[0039] In some embodiments, a first homogenisation step is carried out before an enzymic liquefaction step, and a second homogenisation step is carried out after the enzymic liquefaction step.

[0040] One or more of the homogenisation steps can comprise heating the pulp and the juice (juice-pulp mixture) during homogenisation using a heat exchanger, for more efficient pulp liquefaction, preferably more efficient enzymatic digestion of the pulp.

[0041] The method can comprise a beverage preparation step comprising preparing a beverage from the beverage homogenate. In some embodiments, reduced viscosity, decreased turbidity, and/or improved filterability are achieved. This can be carried out in any suitable way.

[0042] Preferably the beverage homogenate is rendered pourable. Preferably, the beverage has a final viscosity ranging between about 50 cP and about 500 cP, including all about 1 cP increments between 50 and 500, including 51 cP, 52 cP, 53 cP etc. Preferably, the beverage has a final viscosity ranging between about 150 cP and about 250 cP, including all about 1 cP increments between 150 and 250, including 151 cP, 152 cP, 153 cP etc. Preferably, the beverage has a final viscosity of about 200 cP. In some embodiments, the viscosity of the beverage homogenate is modified using, for example, a diluent or base such as fruit and/or vegetable juice, or water.

[0043] In some embodiments, the beverage preparation step comprises adding a functional ingredient, to further improve the health benefits of the beverage. This can be carried out in any suitable way. Any suitable type of functional ingredient can be used. In some embodiments, the functional ingredient can be a sweetener, herbal supplement or nutritional supplement.

[0044] The method can comprise a pasteurisation or preservation step, to thereby produce a pasteurised or preserved beverage. Pasteurisation or preservation can be carried out in any suitable way. This may include hot/warm fill, and/or addition of a suitable preservative, and/or high-pressure processing.

[0045] In some embodiments, the beverage is heated to a temperature of more than 65°C, so that the beverage is still 64°C when bottled or otherwise packaged and sealed. The pasteurisation step can comprise placing the packaged beverage in a pasteurisation bath at 64°C for about 10 minutes.

[0046] In some embodiments, the preservation step can comprise adding a preservative. Any suitable preservative can be used to enhance product stability, such as dimethyl decarbonate, or any other suitable processing aid (eg. antioxidant, organic acid or acidulant).

[0047] The method can comprise a packaging step to produce a packaged or bottled beverage. This step can be carried out in any suitable way. In some embodiments, the beverage is packaged into bottles utilising a method that effectively preserves the beverage for the intended shelf life. This may include hot/warm fill, and/or addition of a suitable preserving compound, and/or high-pressure processing.

[0048] The method can comprise a storage step to produce a stored beverage. In some embodiments, the stored beverage is cooled, labelled, and stored for distribution. With a pome fruit beverage, for example, it may be necessary to store refrigerated to prevent the colour from darkening too quickly. This may be true for other fruit and vegetable based beverages. In some embodiments, the stored beverage is frozen.

[0049] According to a second embodiment of the present invention, there is provided a method of preparing a beverage substantially from the whole edible part of fruit and/or vegetable, the method comprising the steps of:

[0050] optionally, a preparation step for preparing the fruit and/or vegetable, to thereby produce a prepared fruit and/or vegetable;

[0051] a non-edible part removal step for removing any non-edible part of a first fruit and/or vegetable batch, to thereby produce a first processed fruit and/or vegetable batch;

[0052] a pulping step for substantially pulping the first processed fruit and/or vegetable batch, to thereby produce a first processed fruit and/or vegetable pulp;

[0053] a pulping step for substantially pulping a second whole fruit and/or vegetable batch with non-edible parts left in, to thereby produce a second whole fruit and/or vegetable pulp;

[0054] an extraction step for extracting juice from the second whole fruit and/or vegetable pulp;

[0055] optionally, at least one spoilage prevention step for preventing or reducing spoilage;

[0056] a mixing step for mixing the juice extracted from the second whole fruit and/or vegetable pulp with the first processed fruit and/or vegetable pulp, to produce a juice-pulp mixture;

[0057] a pulp liquefaction step for liquefaction of the juice-pulp mixture;

[0058] at least one homogenisation step for homogenising the juice-pulp mixture to produce a beverage homogenate; and

[0059] a beverage preparation step comprising preparing a beverage from the beverage homogenate, wherein said beverage contains substantially the entire edible part of whole fruit and/or vegetable and is pourable.

[0060] According to a third embodiment of the present invention, there is provided a beverage when produced by the method of the first or second embodiment.

[0061] According to a fourth embodiment of the present invention, there is provided a pome fruit beverage prepared substantially from the entire edible part of whole fruit and retaining the nutritional benefit of substantially the entire edible part of the whole fruit, comprising:

about 50-70% weight/weight fruit pulp, comprising substantially the entire edible part of whole fruit;

about 30-60% weight/weight juice of whole fruit; and

about 0-1% weight/weight antioxidant, such as ascorbic acid,

wherein said beverage retains the nutritional benefit of substantially the entire edible part of whole fruit and said beverage is capable of being poured.

[0062] Preferably the beverage homogenate is rendered pourable. Preferably, the beverage has a final viscosity ranging between about 50 cP and about 500 cP, including all about 1 cP

increments between 50 and 500, including 51 cP, 52 cP, 53 cP etc. Preferably, the beverage has a final viscosity ranging between about 150 cP and about 250 cP, including all about 1 cP increments between 150 and 250, including 151 cP, 152 cP, 153 cP etc. Preferably, the beverage has a final viscosity of about 200 cP.

[0063] Preferably, the beverage comprises about 58-62% weight/weight fruit pulp.

[0064] Preferably, the beverage comprises about 38-42% weight/weight juice.

[0065] Preferably, the beverage comprises anywhere between about 0.05% weight/weight to about 0.15% weight/weight antioxidant (e.g. ascorbic acid), including all 0.01 increments between 0.05 and 0.15, including 0.06, 0.07, 0.08, 0.09%, etc. Preferably, about 0.1% weight/weight antioxidant (e.g. ascorbic acid) is used.

[0066] Preferably, the beverage is prepared from the entire edible part of the pome fruit, which includes the peel.

[0067] Preferably, the beverage is prepared from the entire edible part of an apple, which preferably includes the peel.

[0068] Preferably, the beverage is prepared from two batches of pome fruit such as apple, whereby the pulp is obtained from a first batch of apples, preferably processed to lack non-edible parts, and the juice is extracted from a second batch of apples, preferably obtained from whole apples containing non-edible parts.

[0069] Any of the features described herein can be combined in any combination with any one or more of the other features described herein within the scope of the invention.

[0070] The reference to any prior art in this specification is not, and should not be taken as an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge.

BRIEF DESCRIPTION OF THE FIGURES

[0071] Figure 1 shows a process for preparing a 'whole apple' beverage, according to an embodiment of the present invention.

[0072] Preferred features, embodiments and variations of the invention may be discerned

from the following Detailed Description which provides sufficient information for those skilled in the art to perform the invention. The Detailed Description is not to be regarded as limiting the scope of the preceding Summary of the Invention in any way.

DETAILED DESCRIPTION

Example 1 – A method of production of a pome fruit beverage

[0073] This Example describes a method of producing a beverage comprising fresh Granny Smith apples, produced using a pectinase enzyme and a two-stage homogenisation process. See Figure 1 for a schematic overview.

[0074] Fresh Granny Smith apples 1a, 1b were prepared by washing and/or sanitising. A first batch of whole apples 1a, retaining its non-edible parts, was pulped 2a and pressed to extract the juice 3a. Ascorbic acid 4a was added to reduce colour degradation of the juice 3a. A second batch of apples 1b was processed so as to have its non-edible parts removed (core and seeds) 2b and then was pulped 3b. In this way, the pulp 3b was devoid of non-edible parts. In the required proportion the juice 3a and a pectinase enzyme (100 ppm) 5 were both added to the pulp 3b to form a juice-pulp mixture. This mixture was then homogenised 6 and heated simultaneously. Homogenisation was completed using a Silverson High™ Shear In-Line mixer until the composition achieved a fine particle size. The mixture was heated to 55°C and held for 30 minutes. This step allowed the pectinase enzyme to enzymatically ferment the mixture, breaking down the soluble pectin and cell wall components. This heating step was followed by another homogenisation step 7 that was performed until the viscosity of the prepared beverage 8 was such that it was pourable as a drink (approximately 200 cP). The beverage was dispensed into bottles and pasteurised 9 in a bath at 64°C for 10 minutes. Finally, the beverage was cooled, labelled, and stored below 4°C for distribution.

[0075] The beverage comprises the following ingredients:

about 62% weight/weight Granny Smith apple pulp (comprising all edible parts, including the peel);

about 38% weight/weight Granny Smith apple juice; and

about 0.1% weight/weight ascorbic acid.

Example 2 – A method of production of a pome fruit beverage

[0076] This Example describes a method of producing a beverage comprising Pink Lady apples, produced using a pectinase enzyme and a two-stage homogenisation process. See Figure 1 for a schematic overview.

[0077] Fresh Pink Lady apples were prepared by washing and/or sanitising. A first batch of whole apples 1a, retaining its non-edible parts, was pulped 2a and pressed to extract the juice 3a. Ascorbic acid 4a was added to reduce colour degradation of the juice 3a. A second batch of apples 1b was processed so as to have its non-edible parts removed (core and seeds) 2b and then was pulped 3b. In this way, the pulp 3b was devoid of non-edible parts. In the required proportion the juice 3a and a pectinase enzyme (100 ppm) 5 were both added to the pulp 3b to form a juice-pulp mixture. This mixture was then homogenised 6 and heated simultaneously. Homogenisation was completed using a Silverson High™ Shear In-Line mixer until the composition achieved a fine particle size. The mixture was heated to 55°C and held for 30 minutes. This step allowed the pectinase enzyme to enzymatically ferment the mixture, breaking down the soluble pectin and cell wall components. This heating step was followed by another homogenisation step 7 that was performed until the viscosity of the prepared beverage 8 was such that it was pourable as a drink (approximately 200 cP). The beverage was dispensed into bottles and pasteurised 9 in a bath at 64°C for 10 minutes. Finally, the beverage was cooled, labelled, and stored below 4°C for distribution.

[0078] The beverage comprised the following ingredients (all weight/weight):

about 58% weight/weight Pink Lady apple pulp (comprising all edible parts, including the peel);

about 42% weight/weight Pink Lady apple juice; and

about 0.1% weight/weight ascorbic acid.

[0079] The prepared beverages from the above Examples are ready-to-drink beverages. The prepared beverage is not a “juice”, as it is not an extract of the fruit, and unlike a juice, it contains substantially all edible parts of the fruit. It also differs from what is normally known as a “smoothie”, because of its “whole fruit” composition.

[0080] The method of beverage preparation may involve a combination of more than one type of substantially whole fruit and/or substantially whole vegetable. The beverage could further include one or more functional ingredients to further improve health benefits of the beverage.

[0081] The method enables the preparation of a drinkable “whole fruit and/or whole vegetable” (including peel when appropriate – which will mostly be the case) beverage, therefore delivering the nutritional benefits of whole fruit and/or whole vegetable. The method allows the inclusion of more “whole fruit” and/or “whole vegetable” than is possible when prepared using the steps normally used to produce a “smoothie” or “juice”.

[0082] Key advantages of the method as exemplified include:

[0083] The use of a pulp liquefaction/liquefaction step to break down components (e.g. pectin in fruit) that otherwise causes the beverage to be too viscous to be drinkable as a pleasant beverage.

[0084] The use of two stages of homogenisation which performs the twin functions of:

1. Breaking down initial particle size of the pulp so that the pulp liquefaction step is much more effective.
2. Reducing the particle size so as to assist in reducing viscosity of the beverage, provide a smooth mouthfeel, and prevent significant separation during storage.

[0085] In the present specification, the word ‘comprising’ and its derivatives including ‘comprises’ and ‘comprise’ include each of the stated integers but does not exclude the inclusion of one or more further integers.

[0086] Reference throughout this specification to ‘one embodiment’ or ‘an embodiment’ means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearance of the phrases ‘in one embodiment’ or ‘in an embodiment’ in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more combinations

[0087] In compliance with the statute, the invention has been described in language more or less specific to structural or methodical features. It is to be understood that the invention is not limited to specific features shown or described since the means herein described comprises preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims (if any) appropriately interpreted by those skilled in the art.