Pre-microfiltration or ultrafiltration to clarify

Selective nanofiltration or reverse osmosis membrane separation

Permeate product (electrolyte composition or simulation of plant sap)

Concentration by evaporation or reverse osmosis membranes

Electrolyte concentrate for dilution

Cane juice, fresh or clarified

Retentate to sugar production

Figure 1

(54) Title: PLANT-BASED ELECTROLYTE COMPOSITIONS

(57) Abstract: This invention relates, inter alia, to various plant-based electrolyte compositions, methods of preparing them and methods of using them. One embodiment concerns a plant-based electrolyte composition comprising a plant-derived electrolyte content high in potassium relative to sodium, and a plant-derived carbohydrate content less than about 6% weight/volume. Another embodiment concerns a method for re-hydrating an individual or preventing dehydration or over-hydration of an individual or for preventing or treating potassium deficiency in an individual, by administering to the individual a plant-based electrolyte composition. The electrolyte compositions can be prepared from sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, maple sap, vegetable juice or fruit juice.
PLANT-BASED ELECTROLYTE COMPOSITIONS

TECHNICAL FIELD

This invention relates, inter alia, to plant-based electrolyte compositions and to methods of preparing them. In one embodiment the invention concerns natural electrolyte compositions prepared from sugarcane that have an electrolyte content high in potassium relative to sodium and a low carbohydrate content in comparison with most commercially available plant juice drink products.

BACKGROUND ART

Drink products are consumed to replace fluids and minerals (salts/electrolytes) lost in sweating and excretion. Plain or natural water has a low mineral content and therefore does not adequately replace such minerals. It is also limited in its thirst quenching ability and therefore can provide lower effectiveness in satiating water intake compared to other drink products.

Electrolyte drink products are consumed to replace salts (minerals/electrolytes) lost due to sweating or gastrointestinal diarrhoea. The salts are essential for muscle and nerve functioning. Commercially available electrolyte drink products are conventionally formulated using mainly sodium salts with glucose and other ingredients mimicking the content of sweat and plasma as well as providing nutrients thought to be of assistance in recovery from exercise. These 'chemical mixtures' are mainly sodium salt based but for most of the population sodium salt intake already greatly exceeds dietary recommendations. Excessive sodium intake due to its use in cooking and processed foods is a noted and widespread cause of raised blood pressure and dietary recommendations are to reduce levels.

Commercially available energy drink products are formulated to provide a boost of carbohydrate energy to the working muscles which may be aided by the addition of caffeine or other stimulants. Consumption of the higher levels of sugars while rehydrating can result in net energy intake above that lost in exercise.
Commercially available juice drink products are sold as a natural fluid replacement. Most juices are naturally low in sodium and high in potassium salts but normally contain 6-12% weight/volume carbohydrates and are hyper-osmotic compared to human blood plasma. The use of juices in re-hydrating can result in high energy intake and a contribution to weight gain due to their natural sugar content. Fruit juices also have an acidic nature with a low pH due to organic acids that is counter balanced in taste by the sugar. Acid fruit juices can exacerbate gastrointestinal conditions causing stomach upset or irritation to the mouth and throat. The acidic nature can also contribute to erosion of the tooth enamel.

DISCLOSURE OF INVENTION

An object of the present invention is to provide plant-based (naturally-based) electrolyte compositions for consumption that have a low, or substantially no, carbohydrate/sugar content and an electrolyte content rich in potassium relative to sodium, as well as methods for preparing them. Another object of the present invention is to provide the public with a useful or commercial choice.

According to a first aspect of the present invention there is provided a plant-based electrolyte composition comprising:

- a plant-derived electrolyte content high in potassium relative to sodium; and
- a plant-derived carbohydrate content less than about 6% weight/volume.

Preferably the carbohydrate content of the electrolyte composition is less than about 6% weight/volume (w/v), 5% w/v, 4% w/v or 3% w/v and even more preferably about 0.2% w/v (although other percentages are envisaged), such that the content is significantly less than that of commercially available juice drink products. However, the carbohydrate content will depend on the type of plant or plants from which the plant-based electrolyte composition is prepared and its method of preparation.

Preferably the electrolyte composition comprises about 0.050% to 0.200% w/v potassium, more preferably about 0.060% to 0.130% w/v potassium, and even more preferably about 0.064% to 0.109% w/v potassium (although other percentage ranges are
envisaged), such that the electrolyte is of sufficient quantity for the intended use and is of higher content that some commercially available electrolyte drink products. However, the potassium content will depend on the type of plant or plants from which the plant-based electrolyte composition is prepared and its method of preparation.

Preferably the electrolyte composition comprises low level sodium of about 0.000% to 0.050% w/v sodium, more preferably about 0.001% to 0.030% w/v sodium, and even more preferably about 0.007% to 0.030% w/v sodium (although other percentage ranges are envisaged), so as to minimise or avoid the problems caused by commercially available high sodium products. However, the sodium content will depend on the type of plant or plants from which the plant-based electrolyte composition is prepared and its method of preparation.

The electrolyte composition can comprise low molecular weight phenolic antioxidants of about 0.000% to 0.200% w/v, more preferably about 0.002% to 0.133% w/v, and even more preferably about 0.006% to 0.062% w/v (although other percentage ranges are envisaged). This may be useful for some forms of drink products. However, the phenolic antioxidants content will depend on the type of plant or plants from which the plant-based electrolyte composition is prepared and its method of preparation.

The electrolyte composition can comprise a low organic acid content so as to avoid an acidic taste that otherwise may need to be masked by sugar or other specific additive. The electrolyte composition preferably comprises a low organic acid content of about 0.01% to 1.60% w/v, more preferably about 0.05% to 0.50% w/v, and even more preferably about 0.11% to 0.21% w/v (although other percentage ranges are envisaged). However, the organic acid content will depend on the type of plant or plants from which the plant-based electrolyte composition is prepared and its method of preparation.

A typical sugarcane-based electrolyte composition can comprise, for example, about $K^+$ - 0.064 to 0.109% w/v, $Na^+$ - 0.002 to 0.030% w/v, $Mg^{2+}$ - 0.002 to 0.010% w/v and 0.5 to 2.0% w/v carbohydrates (mainly monosaccharides glucose and fructose).

A typical apple juice-based electrolyte composition can comprise, for example, about $K^+$ - 0.05 to 0.100% w/v, $Na^+$ - 0.002 to 0.020% w/v, $Mg^{2+}$ - 0.002 to 0.010% w/v and 0.5 to 5.0% w/v carbohydrates (mainly monosaccharides glucose and fructose).
The plant-based electrolyte composition can be prepared from a substantially liquid extract of any suitable type of plant or plants. The term "substantially liquid extract of a plant" is to be understood herein as referring to a liquid, a substantially liquid, a substantially liquefied and/or a liquefied extract of a plant that may either contain or not contain suspended particulate matter. The term is meant to encompass, but not be limited to, plant-derived waters, saps, juices, syrups and other types of viscous and non-viscous liquids and liquefied plant parts.

The substantially liquid extract can be, for example, sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, maple sap, vegetable juices such as carrot juice, and fruit juices such as apple and orange juice. Preferably the plant is of the type normally used in the manufacture of sugar, eg. sugarcane and sugar beet, and more preferably sugarcane.

The electrolyte composition can be processed to any suitable final form. It can be in a liquid (free-flowing or viscous), gelatinous or solid form. The composition can be formulated, for example, as a drink product/beverage, concentrate, additive for other drink products, gel, powder, effervescent powder, granule, capsule or tablet.

In the case of dried or concentrated products made from the electrolyte the percentage composition will vary proportionally to the water removed.

In preferred embodiments, the composition is formulated as a re-hydrating drink product or osmotic or hypo-osmotic electrolyte replacement drink product (for athletes, for example) or a dietary source of potassium.

It is possible that the drink product could be in the form of an alcoholic beverage, mineral water, soda water, carbonated water, tonic water or syrup, for example. The electrolyte composition could be mixed with alcohol or different types of waters, including distilled and de-ionised water.

Depending on the form of the composition, the composition can further comprise at least one or more of the following types of ingredients: an active (including biologically active) agent, nutrient, dietary supplement, stimulant, sweetening agent, flavouring agent, colouring agent, binding agent, emulsifier, buffering agent, disintegrating agent, absorption enhancer, lubricant, glidant, flow regulating agent, viscosity modifying agent, diluent and preservative.
For example, the composition can comprise at least one or more of the following types of ingredients: an amino acid, vitamin, mineral, additional electrolyte, protein (eg. calcium caseinate, whey protein, whey protein isolate, soy protein, casein hydrolyzate, meat protein, yeast concentrate), caffeine or other stimulant and dietary fibre.

According to a second aspect of the present invention there is provided a plant-based electrolyte composition according to the first aspect in the form of a concentrate.

The electrolyte composition can be concentrated about 5 to 40 times (preferably about 20 times), for example, depending on the sugar content to make a liquid concentrate suitable for storage and shipment. The concentrate can preferably be readily reconstituted into ready-to-consume drink products to be osmotic or hypo-osmotic or hyper-osmotic as desired by the application.

According to a third aspect of the present invention there is provided a drink product prepared from a plant-based electrolyte composition according to the first aspect or a concentrate according to the second aspect.

The drink product can be, for instance, for re-hydrating an individual, for preventing dehydration or over-hydration of an individual. The drink product can be an electrolyte replacement drink product or a dietary source of potassium.

Gatorade™ is an example of a commercially available drink product that athletes drink to restore electrolytes in the body after participating in sports and to avoid dehydration (although that drink product is unlike the present invention in that it is comparatively rich in sodium and not naturally based).

According to a fourth aspect of the present invention there is provided a method for re-hydrating an individual or preventing dehydration or over-hydration of an individual or for preventing or treating potassium deficiency in an individual, said method comprising administering to the individual a composition according to the first aspect, a concentrate according to the second aspect or a drink product according to the third aspect of the invention.

According to a fifth aspect of the present invention there is provided the use of a composition according to the first aspect, a concentrate according to the second aspect or a drink product according to the third aspect of the invention in the preparation of a
medicament for re-hydrating an individual, for preventing dehydration or over-hydration of an individual, or for preventing or treating potassium deficiency in an individual.

According to a sixth aspect of the present invention there is provided a method of preparing a plant-based electrolyte composition, wherein the method comprises the step of processing a substantially liquid extract of a plant to produce a plant-based electrolyte composition according to the first aspect of the invention.

According to a seventh aspect of the present invention there is provided a method of preparing a plant-based electrolyte composition in the form of a concentrate, wherein the method comprises the step of processing a plant-based electrolyte composition prepared according to the sixth aspect of the present invention to produce the concentrate according to the second aspect of the invention.

According to an eighth aspect of the present invention there is provided a method of preparing a drink product from a plant-based electrolyte composition or a concentrate thereof, wherein the method comprises the step of mixing the plant-based electrolyte composition prepared according to the sixth aspect or the concentrate prepared according to the seventh aspect of the invention with at least one other ingredient to produce the drink product.

Any suitable type or types of processing steps can be used. For example, liming, clarification, filtration and evaporation steps can be used. Further steps such as initial plant-crushing, affination, decolourisation, crystallisation and recovery can be used, if required.

Preferably membrane separation technology is used to filter out and reduce the carbohydrate content yet retain most of the minerals/salts/electrolytes, through selection of membranes with different pore sizes. Preferably the membrane process is operated to reduce the initial carbohydrate content to about 0-6% w/v but optimally 0-2% w/v, yet yielding greater than about 60% w/v concentration and more preferably greater than about 80% w/v potassium concentration in the electrolyte composition.

Microfiltration or ultrafiltration can be used, for example, to clarify the substantially liquid extract.
Nanofiltration (polymeric, ceramic and metallic membranes) can be used, for example, to separate at least some of the carbohydrate content from the electrolyte content.

Nanofiltration (polymeric, ceramic and metallic membranes) can be used, for example, to separate at least some of the organic acid content from the electrolyte content.

Evaporation and/or filtration step (eg. reverse osmosis) can be used, for example, to prepare the concentrate.

If using sugarcane juice, the juice can be briefly heat treated at 80°C to control microbial and enzymatic activity followed by coarse filtration, prior to lowering the carbohydrate content. Alternatively, lime clarified juice can be used.

According to a ninth aspect of the present invention there is provided a method of preparing a sugarcane-based electrolyte composition, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify fresh or clarified sugarcane juice; and
2. using a step of nanofiltration to reduce the clarified juice's carbohydrate content to produce a sugarcane-based electrolyte composition comprising an electrolyte content high in potassium relative to sodium and a carbohydrate content less than about 6% weight/volume; and optionally
3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.

According to a tenth (more general) aspect of the present invention there is provided a plant-based electrolyte composition, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify a substantially liquid extract of a plant; and
2. using a step of nanofiltration to reduce the clarified substantially liquid extract's carbohydrate content to produce a plant-based electrolyte composition comprising an electrolyte content high in potassium relative to sodium and a carbohydrate content less than about 6% weight/volume; and optionally
3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.

According to an eleventh aspect of the present invention there is provided a method for making a drink product from a substantially liquid extract of a plant using membrane filtration technology, wherein the drink product simulates plant sap, said method comprising the steps of:

1. clarifying the substantially liquid extract of the plant;
2. using membranes selected to have pore sizes suitable to remove some of, but preferably all or most of, the sugar and some of the organic acids of the substantially liquid extract but leaving most of the monovalent ions including potassium in the substantially liquid extract; and
3. optionally, concentrating the substantially liquid extract by reverse osmosis membranes and/or evaporation to make a substantially liquid extract concentrate.

According to a twelfth aspect of the present invention there is provided a plant juice-derived drink product that simulates plant sap in its mineral, sugar and antioxidant content.

According to a thirteenth aspect of the present invention there is provided a plant-based electrolyte composition prepared from a substantially liquid extract of a plant by membrane separation technology, said plant-based electrolyte composition comprising:

1. a plant-derived electrolyte content high in potassium relative to sodium; and
2. a plant-derived carbohydrate content less than about 6% weight/volume, and preferably 0-2% weight/volume plant-derived carbohydrate,

wherein the plant-based electrolyte composition comprises greater than about 80% weight/volume potassium of an original potassium concentration of the substantially liquid extract of the plant, but more preferably greater than about 95% weight/volume of the original potassium concentration of the substantially liquid extract of the plant.

The inventors have found that during the concentration of sugar from juice by membrane technology, a product stream can be generated that is similar to plant sap, being the liquid form that plants store and transport liquid and nutrients through the plant from roots to leaves. The inventors have found that the production process can be
controlled to recover most of the mineral/electrolyte/salt and importantly most of the
potassium content but with only a low percentage of the sugar from the juice.

The inventors have also found that the electrolyte composition or concentrated
form thereof can be a good base for a re-hydration or electrolyte replacement drink. It
can have low acidity with a clean and slightly salty taste, without sweetness. When
consumed it can have a good thirst quenching sensation being able to better the control
the sensation of dryness in the mouth and throat associated with a need for liquids. This
in combination with the high potassium to sodium mineral salts ratio and isotonic or
lower concentration makes it effective in re-hydration and preventing over-hydration.

Over-hydration occurs when the normal balance of electrolytes is pushed outside limits
by over-consumption of water. Over-hydration can occur, for example, when athletes
rapidly drink excessive amounts of water or substantially hypo-osmotic electrolyte sports
drinks to avoid dehydration. The result is too much water and not enough salts and
people may become confused or have seizures.

The electrolyte composition can be made by using membranes to achieve a
physical separation of carbohydrates (sugars) to leave small ion electrolytes such as
potassium, and other minor cell constituents similar to the content of plant sap. The
amount of natural sugar including glucose and fructose going into the electrolyte
composition can be varied between about 0 and 6% w/v (preferably 2% w/v) through
selection of membranes with different pore sizes. The resulting electrolyte composition
can be concentrated about 5-40 times depending on the sugar content to make a clear
liquid concentrate suitable for storage and shipment. The concentrate can be reconstituted
into ready-to-drink products.

The drink product can be a natural isotonic re-hydration drink product low in
carbohydrate and high in potassium. It is an alternative to water (which has no
electrolytes), juice (which is high in sugar) and formulated electrolyte drinks (produced
by the mixing of chemicals). To the inventors’ knowledge there is no publicly available
prior information for making a plant sap like product from juices by removal of sugar
and acids using membranes or to using such a product as a drink or high potassium
electrolyte replacement product.
The mechanisms controlling thirst have been extensively researched as well as some of the thirst quenching properties of water and other drinks. While the thirst quenching effect is currently a subjective and unexpected observation the effect can be scientifically measured. However there appears to be no reference in literature that looks at the thirst quenching properties of sugar and acid depleted juices or plant saps. There appears to be no prior literature showing the superior thirst quenching properties of such a product although low sugar, low acid products are known to generate this effect but not fruit juices. No discussion of the potential mechanism of thirst quenching in relation to high potassium electrolyte content have been found. Likewise no studies in prevention of over-hydration using natural electrolyte products have been found although the mechanism is well understood. Treatment consists of supplying salts and/or diuretics to bring the plasma electrolytes into the required range for normal cell functioning. The natural electrolyte composition could prevent the problem from occurring.

The impact of high sodium and the need to reduce the level for health particularly blood pressure reduction is extensively published. No commercial drink products other than juice and fresh foods have been found that are made to promote low sodium, high potassium intake.

It is to be appreciated that the first to twelfth aspects of the invention can have one or more features as described anywhere in the section entitled "Disclosure of the Invention" (provided that the features are not incompatible with one another) or as described in the "Preferred Embodiments of the Invention" section.

In order that the invention may be more readily understood and put into practice, preferred embodiments thereof will now be described with reference to the figure, by way of example only.

Figure 1 is a schematic showing preparation of a sugarcane-based electrolyte composition and its concentrate using sugarcane juice as starting material.

**PREFERRED EMBODIMENTS OF THE INVENTION**

Although the preparation of electrolyte compositions and their concentrates from sugarcane juice and apple juice will be exemplified below, other plant sources used for the manufacture of sugar can be used, such as sugar beet, sweet sorghum, palm syrup,
maple sap, vegetable juices such as carrot juice and fruit juices such as orange (but excluding coconut water or coconut juice).

However, as explained above, the actual electrolyte, sugar/carbohydrate, flavonoid/phenolic antioxidant and organic acid content of each electrolyte composition will ultimately depend on the type of plant or plants from which the plant-based electrolyte composition is prepared as well as its method of preparation.

**Example 1 - Preparation of a sugarcane-based electrolyte composition and its concentrate**

This example describes the preparation of a sugarcane-based electrolyte composition and its concentrate using sugarcane juice as starting material. A schematic of the process is shown in figure 1.

Table 1 below shows the typical composition of sugarcane juice based on solids (Walford S (1996) Composition of cane juice. *Proceedings of the South African Sugar Technologists' Association* 70, 265-266.)

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Component</th>
<th>Content (% w/w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugars</td>
<td>Sucrose</td>
<td>81-87</td>
</tr>
<tr>
<td></td>
<td>Reducing sugars</td>
<td>3-6</td>
</tr>
<tr>
<td></td>
<td>Oligosaccharides</td>
<td>0.06-0.6</td>
</tr>
<tr>
<td></td>
<td>Polysaccharides (including gums and dextrins)</td>
<td>0.2-0.8</td>
</tr>
<tr>
<td>Salts</td>
<td>Inorganic salts:</td>
<td>1.5-3.7</td>
</tr>
<tr>
<td></td>
<td>Potassium (K₂O)</td>
<td>0.77-1.31</td>
</tr>
<tr>
<td></td>
<td>Sodium (Na₂O)</td>
<td>0.01-0.04</td>
</tr>
<tr>
<td></td>
<td>Magnesium (MgO)</td>
<td>0.10-0.39</td>
</tr>
<tr>
<td>Organic non-sugars</td>
<td>Organic acids</td>
<td>0.7-1.3</td>
</tr>
<tr>
<td></td>
<td>Amino acids</td>
<td>0.5-2.5</td>
</tr>
<tr>
<td></td>
<td>Dextrins</td>
<td>0.1-0.6</td>
</tr>
<tr>
<td></td>
<td>Starch</td>
<td>0.11-0.5</td>
</tr>
<tr>
<td></td>
<td>Gums</td>
<td>0.02-0.05</td>
</tr>
<tr>
<td></td>
<td>Waxes, fats, phospholipids</td>
<td>0.05-0.15</td>
</tr>
<tr>
<td></td>
<td>Colourants</td>
<td>0.1</td>
</tr>
<tr>
<td>Insolubles</td>
<td>Sand, bagasse, etc.</td>
<td>0.15-1.0</td>
</tr>
</tbody>
</table>

Pre-filtered sugarcane juice from a mill (essentially as described in table 1) was microfiltered using a 0.1 μm pore size membrane to remove any fine particulate material.

200 L of microfiltered juice was then sent through a nanofiltration (NF) membrane of specific pore size to produce an electrolyte composition fraction
comprising a high electrolyte content relative to a carbohydrate content, wherein the electrolyte content is high in potassium relative to sodium. Most of the carbohydrate/sugar content and large molecules were separated as a retentate fraction from the permeate fraction (ie. permeate fraction = electrolyte composition).

Approximately 30% (61.9 L) of the 200 L micro filtered juice feed was separated and collected as single strength electrolyte, ie. the electrolyte composition, but could be optimised to collect more in the permeate fraction. If desired, the retentate can be returned to the refinery to purify the sugar.

The electrolyte composition (single strength electrolyte) was concentrated to 3.2 L with almost 20 times concentration using a reverse osmosis (RO) membrane.

A typical non-concentrated electrolyte composition is: K+ - 0.064 to 0.109% w/v, Na+ - 0.002 to 0.030% w/v, Mg2+ - 0.002 to 0.10% w/v and 0.5 to 2.0% w/v carbohydrate/sugars (mainly monosaccharides). This composition also contains some low molecular weight phenolic antioxidants and can be concentrated to yield a stable clear syrup of yellowish colour. The composition is largely devoid of organic acids.

A nutritional panel of the concentrate and the equivalent diluted product is given in table 2 below:

<table>
<thead>
<tr>
<th>Table 2 - Nutrition information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Fat - total</td>
</tr>
<tr>
<td>Carbohydrate, total</td>
</tr>
<tr>
<td>- sugars</td>
</tr>
<tr>
<td>Potassium</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sodium</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Two possible re-hydration drink products, prepared by mixing the non-concentrated electrolyte composition with different ingredients, are described in tables 3 and 4 below.

Table 3 - First re-hydration drink product

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-concentrated electrolyte composition (containing 2% w/v sugar)</td>
<td>999 mL</td>
</tr>
<tr>
<td>Vitamin C (preservative and vitamin)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Orange oil (flavouring agent)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Natural colour (E163)</td>
<td>200 mg</td>
</tr>
</tbody>
</table>

Table 4 – Second re-hydration drink product

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-concentrated electrolyte composition (containing 2% w/v sugar)</td>
<td>900 mL</td>
</tr>
<tr>
<td>Vitamin C (preservative and vitamin)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Natural fruit juice (flavouring and colouring agent)</td>
<td>100 mL</td>
</tr>
</tbody>
</table>

Example 2 - Preparation of a sugarcane-based electrolyte concentrate

This example describes the preparation of a sugarcane-based electrolyte concentrate using clarified sugarcane juice as starting material.

Sugarcane electrolyte concentrate was produced from clarified sugarcane juice filtered through 100 micron stainless steel strainer from a sugar mill. The clarified juice
of about 10.9% w/w total sugars was used in a two-step membrane process to produce sugarcane electrolyte concentrate (sugarcane plant sap concentrate).

A first step of the filtration was conducted using a nanofiltration (NF) membrane at an operating pressure of 35 bar and 40 °C temperature. About 375 kg of the juice was taken into a jacketed stainless steel tank and heated up to 40 °C. The juice from the tank was pumped into a high pressure membrane filtration unit feed tank which is of about 20 kg capacity. The feed was frequently topped-up with fresh juice as the filtration continued while a portion of the retentate (concentrated feed) fraction was withdrawn from the feed tank at regular intervals as it reached the Brix value of about 25.

The NF permeate fraction which was very low in sugar (<1.5% w/w) and mineral (monovalent salts) content almost equal to that of feed was continuously separated. At the end of the trial about 55% of the total feed was separated as low sugar permeate fraction and up to 45% sugar rich fraction as NF retentate.

The NF permeate fraction low in sugar and mineral content similar to that of clarified juice is considered as a single strength natural electrolyte. The single strength electrolyte (SSE) was heated to around 40 °C in a jacketed stainless steel tank and pumped into a membrane unit fitted with a reverse osmosis (RO) membrane at stage 2 filtration. The SSE was concentrated up to twenty-fold at operating pressure of 35 bar and 40 °C temperature. Permeate obtained from stage 2 was only water with zero Brix value. The feed tank was continuously topped-up with fresh SSE as the filtration continued. The process was carried out until the concentration of electrolyte raised to about twenty times of that of the SSE.
Table 5 below shows a typical composition of the sugarcane electrolyte concentrate.

Table 5

<table>
<thead>
<tr>
<th>Fraction weight kg</th>
<th>Total Sugars % w/w</th>
<th>Potassium mg/100g</th>
<th>Sodium mg/100g</th>
<th>Magnesium mg/100g</th>
<th>Total Phenolics as mg GAE/100mL</th>
<th>Titratable Acidity as mg AAE/100mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarified sugarcane juice NF retentate</td>
<td>372.4</td>
<td>10.9</td>
<td>74.6</td>
<td>&lt;5</td>
<td>12</td>
<td>60.8</td>
</tr>
<tr>
<td>NF permeate (SSE)</td>
<td>164.8</td>
<td>23.1</td>
<td>98.1</td>
<td>&lt;5</td>
<td>24</td>
<td>155.5</td>
</tr>
<tr>
<td>Sugarcane electrolyte concentrate</td>
<td>207.6</td>
<td>0.6</td>
<td>60.6</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>10.9</td>
<td>11.7</td>
<td>800.0</td>
<td>22</td>
<td>58.9</td>
<td>153.4</td>
</tr>
</tbody>
</table>

GAE = Gallic Acid Equivalents; AAE = Aconitic Acid Equivalents

Example 3 - Preparation of an apple juice-based electrolyte concentrate

This example describes the preparation of an apple juice-based electrolyte concentrate using apple juice concentrate as starting material.

A commercial apple juice concentrate of about 70 Brix was diluted with seven times RO water to obtain a single strength apple juice. This single strength juice with about 7.9% total sugars by weight was used as feed for apple electrolyte production.

A two-step membrane filtration process similar to the one described in Example 2 was used to produce apple electrolyte concentrate.

In step 1 apple juice feed was heated to 40 °C and filtered using a nanofiltration membrane. The NF permeate, unlike sugarcane juice permeate, was found to have around 4% total sugars. This is because the sugars present in the apple juice are mainly monosaccharides such as fructose and glucose (instead of sucrose as in sugarcane juice) and easily permeate through the NF membrane. In this case permeate and retentate were split in the ratio of 70:30.

The NF permeate with relatively higher sugar concentration compared to sugarcane juice permeate and mineral concentration equal to that of apple juice feed was fed into step 2 membrane filtration. A reverse osmosis membrane was used in step 2 to concentrate single strength electrolyte obtained from step 1. In this case concentration of
the electrolyte was increased only by about 3.5 fold as the feed sugar concentration was already around 4.

Table 6 below shows a typical composition of the apple juice electrolyte concentrate.

<table>
<thead>
<tr>
<th></th>
<th>Fraction weight kg</th>
<th>Total Sugars % w/w</th>
<th>Potassium mg/100g</th>
<th>Sodium mg/100g</th>
<th>Magnesium mg/100g</th>
<th>Total Phenolics as mg GAE/100mL</th>
<th>Titratable Acidity as mg MAE/100mL</th>
</tr>
</thead>
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<tr>
<td>Apple juice feed</td>
<td>403.0</td>
<td>7.9</td>
<td>84.5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>11.9</td>
<td>148</td>
</tr>
<tr>
<td>NF retentate</td>
<td>106.2</td>
<td>16.9</td>
<td>116.0</td>
<td>&lt;5</td>
<td>7</td>
<td>46.1</td>
<td>293</td>
</tr>
<tr>
<td>NF permeate (SSE apple)</td>
<td>296.8</td>
<td>4.1</td>
<td>73.5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>5.4</td>
<td>153</td>
</tr>
<tr>
<td>Apple electrolyte concentrate</td>
<td>83.9</td>
<td>14.5</td>
<td>287.0</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>32.8</td>
<td>759</td>
</tr>
</tbody>
</table>

GAE = Gallic Acid Equivalents  
MAE = Malic Acid Equivalents

Clarified sugarcane juice of Example 2 shows that the NF permeate (SSE) had 38 mg per 100 mL AAE titratable acidity compared with the original juice feed at 88 mg per 100 mL showing that the total acidity was lowered by more than half. However, for apple juice the NF permeate was 153 mg MAE per 100 mL compared with 148 mg per 100 mL in the juice feed. The total acidity was not lowered.

The reason for this is that sugarcane juice contains primarily aconitic acid molecular weight (MW) 174 which is a tricarboxylic acid and an isomer in the formation of citric acid. Apple juice contains primarily malic acid MW 134 which is a dicarboxylic acid. The greater molecular size of aconitic acid results in a higher rejection by the NF membrane. The lowering of total acidity should thus only apply to cane juice or grape (tartaric) or orange (citric) juice, not apple juice.

The NF permeate (SSE) for sugarcane juice had 0.6% total sugars for a juice feed stream of 10.6%. In contrast the NF permeate for apple juice (SSE) had 4.1% total sugars for a juice feed stream of 7.9%. The reason for this is that apple juice is composed mainly glucose and fructose (MW 180) whereas the sugarcane juice is primarily sucrose (MW 360). The residual sugars are therefore less in the cane juice.
In summary, some of the advantages of an electrolyte composition as exemplified include:

- It simulates plant sap having a low sugar content with the minerals and antioxidants reflective of the natural content of the fluid in living cells.
- It has a pleasant naturally slight salty taste with an absence of strong or off-flavours making it suitable to be consumed straight or formulated with flavours and other functional ingredients.
- It provides a natural low calorie source of potassium which is an under consumed nutrient in the diet thereby enabling re-hydration and nutrition with low sugar intake compared to drinking juices.
- It has a high potassium to low sodium ratio that is derived from the natural content of mineral in the cells and is therefore of benefit to limiting sodium intake in the diet where high dietary sodium has been linked to causing raised blood pressure.
- It can be processed by physical separation without addition of chemicals to give a low acid content, low sugar and slightly salty taste that has a faster satiation effect for fluid consumption.
- It has properties of thirst quenching and high potassium mineral balance that counter over-hydration which can be an issue with excessive intake of water.

The foregoing embodiments are illustrative only of the principles of the invention, and various modifications and changes will readily occur to those skilled in the art. The invention is capable of being practiced and carried out in various ways and in other embodiments. It is also to be understood that the terminology employed herein is for the purpose of description and should not be regarded as limiting.

The term "comprise" and variants of the term such as "comprises" or "comprising" are used herein to denote the inclusion of a stated integer or stated integers but not to exclude any other integer or any other integers, unless in the context or usage an exclusive interpretation of the term is required.

Any reference to prior art information in this specification is not an admission that the information constitutes common general knowledge in Australia or elsewhere.
CLAIMS

1. A plant-based electrolyte composition comprising:
   a plant-derived electrolyte content high in potassium relative to sodium; and
   a plant-derived carbohydrate content less than about 6% weight/volume.

2. The plant-based electrolyte composition of claim 1, wherein the carbohydrate content of the electrolyte composition is about 0-6% w/v.

3. The plant-based electrolyte composition of claim 1 or claim 2, wherein the carbohydrate content of the electrolyte composition is about 0-2% w/v.

4. The plant-based electrolyte composition of any one of claims 1 to 3, wherein the electrolyte composition comprises about 0.050% to 0.200% w/v potassium.

5. The plant-based electrolyte composition of any one of claims 1 to 4, wherein the electrolyte composition comprises about 0.064% to 0.109% w/v potassium.

6. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.000% to 0.050% w/v sodium.

7. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.002% to 0.030% w/v sodium.

8. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises a low molecular weight phenolic antioxidants content.

9. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.000% to 0.200% w/v low molecular weight phenolic antioxidants.

10. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.006% to 0.062% w/v low molecular weight phenolic antioxidants.

11. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises a low organic acid content.

12. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.01% to 1.60% w/v organic acid.

13. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.11% to 0.21% w/v organic acid.
14. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition is prepared from a substantially liquid extract of at least one type of plant.

15. The plant-based electrolyte composition of claim 14, wherein the substantially liquid extract is sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, maple sap, vegetable juice or fruit juice.

16. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about K$^+$ - 0.064 to 0.109% w/v, Na$^+$ - 0.002 to 0.030% w/v, Mg$^{2+}$ - 0.02 to 0.10% w/v and about 0.5-2.0% w/v carbohydrates.

17. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition is prepared from sugarcane juice.

18. The plant-based electrolyte composition of any one of claims 1 to 15, wherein the electrolyte composition comprises about K$^+$ - 0.05 to 0.100% w/v, Na$^+$ - 0.002 to 0.010% w/v, Mg$^{2+}$ - 0.002 to 0.010% w/v and 0.5 to 6.0% w/v carbohydrates.

19. The plant-based electrolyte composition of any one of claims 1 to 15 and 18, wherein the electrolyte composition is prepared from apple juice.

20. A concentrate of the plant-based electrolyte composition according to any one of the preceding claims.

21. A drink product prepared from a plant-based electrolyte composition according to any one of claims 1 to 19 or a concentrate according to claim 20.

22. A method for re-hydrating an individual or preventing dehydration or over-hydration of an individual or for preventing or treating potassium deficiency in an individual, said method comprising administering to the individual a composition according to any one of claims 1 to 19, a concentrate according to claim 20 or a drink product according to claim 21.

23. The use of a composition according to any one of claims 1 to 19, a concentrate according to claim 20 or a drink product according to claim 21 in the preparation of a medicament for re-hydrating an individual, for preventing dehydration or over-hydration of an individual, or for preventing or treating potassium deficiency in an individual.
24. A method of preparing a plant-based electrolyte composition, wherein the method comprises the step of processing a substantially liquid extract of at least one type of plant to produce a plant-based electrolyte composition according to any one of claims 1 to 19.

25. A method of preparing a plant-based electrolyte composition in the form of a concentrate, wherein the method comprises the step of concentrating a plant-based electrolyte composition prepared according to claim 24.

26. A method of preparing a drink product from a plant-based electrolyte composition or a concentrate thereof, wherein the method comprises the step of mixing the plant-based electrolyte composition prepared according to claim 24 or the concentrate prepared according to claim 25 with at least one other ingredient to produce the drink product.

27. A method of preparing a plant-based electrolyte composition, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify a substantially liquid extract of a plant; and

2. using a step of nanofiltration to reduce the clarified substantially liquid extract's carbohydrate content to produce a plant-based electrolyte composition comprising an electrolyte content high in potassium relative to sodium and a carbohydrate content less than about 6% weight/volume; and optionally

3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.

28. A method of preparing a sugarcane-based electrolyte composition, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify fresh or clarified sugarcane juice; and

2. using a step of nanofiltration to reduce the clarified juice's carbohydrate content to produce a sugarcane-based electrolyte composition comprising an electrolyte content high in potassium relative to sodium and a carbohydrate content less than about 6% weight/volume; and optionally

3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.
29. A method for making a drink product from a substantially liquid extract of a plant using membrane filtration technology, wherein the drink product simulates plant sap, said method comprising the steps of:
   1. clarifying the substantially liquid extract of the plant;
   2. using membranes selected to have pore sizes suitable to remove some of, but preferably all or most of, the sugar and organic acids of the substantially liquid extract but leaving most of the monovalent ions including potassium in the substantially liquid extract; and
   3. optionally, concentrating the substantially liquid extract by reverse osmosis membranes and/or evaporation to make a substantially liquid extract concentrate.

30. A plant juice-derived drink product that simulates plant sap in its mineral, sugar and antioxidant content.

31. A plant-based electrolyte composition prepared from a substantially liquid extract of a plant by membrane separation technology, said plant-based electrolyte composition comprising:

   a plant-derived electrolyte content high in potassium relative to sodium; and

   a plant-derived carbohydrate concentration less than about 6% weight/volume, and preferably 0-2% weight/volume plant-derived carbohydrate,

   wherein the plant-based electrolyte composition comprises greater than about 80% weight/volume potassium of an original potassium concentration of the substantially liquid extract of the plant, but more preferably greater than about 95% weight/volume of the original potassium concentration of the substantially liquid extract of the plant.
CLAIMS

1. A plant-based electrolyte composition prepared for consumption comprising:
   a plant-derived electrolyte content comprising about 0.050% to 0.200% weight/volume potassium and about 0.000% to 0.050% weight/volume sodium; and
   a plant-derived carbohydrate content less than about 6% weight/volume, wherein the electrolyte composition is prepared from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice.

2. The plant-based electrolyte composition of claim 1, wherein the carbohydrate content of the electrolyte composition is about 0-2% w/v.

3. The plant-based electrolyte composition of claim 1 or claim 2, wherein the electrolyte composition comprises about 0.064% to 0.109% w/v potassium.

4. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.002% to 0.030% w/v sodium.

5. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises a low molecular weight phenolic antioxidants content.

6. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.000% to 0.200% w/v low molecular weight phenolic antioxidants.

7. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.006% to 0.062% w/v low molecular weight phenolic antioxidants.

8. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises a low organic acid content.

9. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.01% to 1.60% w/v organic acid.

10. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition comprises about 0.11% to 0.21% w/v organic acid.

11. The plant-based electrolyte composition of any one of the preceding claims, wherein the electrolyte composition is prepared from sugarcane juice.
12. The plant-based electrolyte composition of any one of claims 1 to 10, wherein the electrolyte composition is prepared from fruit juice.
13. The plant-based electrolyte composition of any one of claims 1 to 10, wherein the electrolyte composition is prepared from sugar beet juice.
14. The plant-based electrolyte composition of claim 12, wherein the electrolyte composition is prepared from apple juice.
15. The plant-based electrolyte composition of claim 1, wherein the electrolyte composition comprises about K\(^+\) - 0.064 to 0.109% w/v, Na\(^+\) - 0.002 to 0.030% w/v, Mg\(^{2+}\) - 0.02 to 0.10% w/v and about 0.5-2.0% w/v carbohydrates.
16. The plant-based electrolyte composition of claim 1, wherein the electrolyte composition comprises about K\(^+\) - 0.05 to 0.100% w/v, Na\(^+\) - 0.002 to 0.010% w/v, Mg\(^{2+}\) - 0.002 to 0.010% w/v and 0.5 to 6.0% w/v carbohydrates.
17. A concentrate of the plant-based electrolyte composition according to any one of the preceding claims.
18. A drink product prepared from a plant-based electrolyte composition according to any one of claims 1 to 16 or a concentrate according to claim 17.
19. A method for re-hydrating an individual or preventing dehydration or over-hydration of an individual or for preventing or treating potassium deficiency in an individual, said method comprising administering to the individual a composition according to any one of claims 1 to 16, a concentrate according to claim 17 or a drink product according to claim 18.
20. The use of a composition according to any one of claims 1 to 16, a concentrate according to claim 17 or a drink product according to claim 18 in the preparation of a medicament for re-hydrating an individual, for preventing dehydration or over-hydration of an individual, or for preventing or treating potassium deficiency in an individual.
21. A method of preparing a plant-based electrolyte composition, wherein the method comprises the step of processing a substantially liquid extract of at least one type of plant to produce a plant-based electrolyte composition according to any one of claims 1 to 16.
22. A method of preparing a plant-based electrolyte composition in the form of a concentrate, wherein the method comprises the step of concentrating a plant-based electrolyte composition prepared according to claim 21.
23. A method of preparing a drink product from a plant-based electrolyte composition or a concentrate thereof, wherein the method comprises the step of mixing the plant-based electrolyte composition prepared according to claim 21 or the concentrate prepared according to claim 22 with at least one other ingredient to produce the drink product.

24. A method of preparing a plant-based electrolyte composition for consumption, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify a substantially liquid extract of a plant; and

2. using a step of nanofiltration to reduce the clarified substantially liquid extract's carbohydrate content to produce a plant-based electrolyte composition comprising an electrolyte content of about 0.050% to 0.200% weight/volume potassium, about 0.000% to 0.050% weight/volume sodium and a carbohydrate content less than about 6% weight/volume, wherein the electrolyte composition is prepared from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice; and optionally

3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.

25. A method of preparing a sugarcane-based electrolyte composition for consumption, wherein steps of the method comprise:

1. using a step of microfiltration or ultrafiltration to clarify fresh or clarified sugarcane juice; and

2. using a step of nanofiltration to reduce the clarified juice's carbohydrate content to produce a sugarcane-based electrolyte composition comprising an electrolyte content of about 0.050% to 0.200% weight/volume potassium, about 0.000% to 0.050% weight/volume sodium and a carbohydrate content less than about 6% weight/volume, wherein the electrolyte composition is prepared from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice; and optionally

3. using a step of evaporation or reverse osmosis filtration to prepare a concentrate of the electrolyte composition of step 2.

26. A method for making a drink product from a substantially liquid extract of a plant using membrane filtration technology, wherein the drink product simulates plant
sap and the substantially liquid extract is selected from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice, said method comprising the steps of:

1. clarifying the substantially liquid extract of the plant;

2. using membranes selected to have pore sizes suitable to remove some of, but preferably all or most of, the sugar and organic acids of the substantially liquid extract but leaving most of the monovalent ions including potassium in the substantially liquid extract such that said substantially liquid extract comprises about 0.050% to 0.200% weight/volume potassium, about 0.000% to 0.050% weight/volume sodium and a carbohydrate content less than about 6% weight/volume; and

3. optionally, concentrating the substantially liquid extract by reverse osmosis membranes and/or evaporation to make a substantially liquid extract concentrate.

27. A plant juice-derived drink product that simulates plant sap in its mineral, sugar and antioxidant content, wherein said product comprises about 0.050% to 0.200% weight/volume potassium, about 0.000% to 0.050% weight/volume sodium and a carbohydrate content less than about 6% weight/volume, wherein the product is prepared from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice.

28. A plant-based electrolyte composition prepared from a substantially liquid extract of a plant by membrane separation technology, said plant-based electrolyte composition comprising:

   a plant-derived electrolyte content comprising about 0.050% to 0.200% weight/volume potassium and about 0.000% to 0.050% weight/volume sodium; and

   a plant-derived carbohydrate concentration less than about 6% weight/volume, and preferably 0-2% weight/volume plant-derived carbohydrate,

   wherein the electrolyte composition is prepared from at least one of the group consisting of sugarcane juice, sugar beet juice, sweet sorghum juice, palm syrup, vegetable juice and fruit juice,

   wherein the plant-based electrolyte composition comprises greater than about 80% weight/volume potassium of an original potassium concentration of the
substantially liquid extract of the plant, but more preferably greater than about 95% weight/volume of the original potassium concentration of the substantially liquid extract of the plant.
Cane juice-fresh or clarified

Pre-microfiltration or ultrafiltration to clarify

Selective nanofiltration membrane separation

Retentate to sugar production

Permeate product (electrolyte composition-simulation of plant sap)

Concentration by evaporation or reverse osmosis membranes

Electrolyte concentrate for dilution

Figure 1
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A23L 2/74 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC WI (A23L 2/74, A23L 2/38, beet, sorghum, cane, sugarcane, apple, juice, extract, drink, microfiltration, nanofiltration, ultrafiltration, sugar, carbohydrate)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category* Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No.

(see abstract, Table 1 column 4 rows 2, 4 and 10) 1-2, 4, 6-7, 11, 14-15, 21-24, 30


X (see Sap Chemistry, Syrup-Making) 1-4, 6-7, 11, 13-15, 20-21, 24-25, 30

X US 6406548 B1 (DONOVAN et al.) 18 June 2002
(see abstract, column 8 line 30, column 3 lines 60 to column 4 line 24) 1-18, 21, 24-27, 31

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "Z" document member of the same patent family

Date of the actual completion of the international search 17 August 2011

Date of mailing of the international search report 18.08.2011

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Form PCT/ISA/210 (second sheet) (July 2009)
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<td>US 5403604 A (BLACK, Jr. et al.) 4 April 1995 (see title, abstract, column 1 lines 1-15, column 2 line 13, column 2 lines 15-18, column 2 lines 41-48, column 3 line 31, column 3 lines 51-52, claim 19)</td>
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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX