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(57) Abstract: Disclosed is a liquid fortificant dosing device that can be fitted to a faucet of a water storage chamber and particularly fitted to a faucet of a storage chamber of water purification devices which provide purified potable water and at the same time provide beneficial amounts of fortificants e.g. l0 to 20% RDA/Litre of water are made available in every unit of water that is dispensed. The disclosed device has a dispensing unit which is suitable for comprising fortificant stock solution having viscosity in the range of 50 to 2000 cP, said unit having an opening (2) to the atmosphere positioned above the level of said solution; a differential pressure unit (3), comprising an inlet port (4) connectable to said faucet (8), and an outlet port (5) to dispense fortified water; a dosing tube (7) having a diameter in the range of 0.5 to 3 mm connected at one end to the point of minimum pressure(6) of said differential pressure unit (3) while the other end of the dosing tube (7) dips into said solution; wherein a vent (10) is provided to the atmosphere upstream of said point of minimum pressure (6) in said differential pressure unit (3) and wherein flow rate of water through said faucet (8) is controlled to a substantially constant rate by a mechanical flow control element (11) that is positioned upstream of the differential pressure unit (3).


Declarations under Rule 4.17:
- as to applicant’s entitlement to apply for and be granted a patent (Rule 4.17(b))
- as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.17(in))

Published:
- with international search report (Art. 21(3))
A FAUCET MOUNTED LIQUID FORTIFICANT DOSING DEVICE AND
DISPENSATION METHOD

FIELD OF THE INVENTION

The present invention relates to a liquid fortificant dosing device that can be fitted to a faucet of a water storage chamber and particularly fitted to a faucet of a storage chamber of water purification devices which provide purified potable water. The present invention particularly relates to connecting the fortificant dosing device to an outlet faucet to consistently provide potable water and at the same time provide beneficial amounts of fortificants.

The invention has been developed primarily for use in drinking water application and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of the common general knowledge in the field.

In general having a balanced diet to get enough vitamins and minerals from foods is preferable rather than getting them from supplements. The daily dosage of vitamins and minerals is defined in terms of Recommended Dietary Allowance (RDA). In many populations this can be difficult and it becomes essential to take supplements. When people do not eat or get a healthy diet every day, taking a fortificant that contains the recommended daily allowances for vitamins and minerals to substitute becomes necessary. Taking a fortificant is particularly useful for people who have a vitamin or mineral deficiency.
Generally, deficiencies that people may develop include deficiencies of folic acid, Vitamin B12, Vitamin C, Vitamin D, iron, calcium, magnesium, phosphorus, potassium, sodium, and zinc.

Water is a crucial part of the daily diet and on an average, 60 percent of the body weight is constituted of water. Every system in the body depends on water. In general everyone consumes about 1 to 3 litres of water per day and providing these vitamins and minerals by fortifying water would be very useful.

A large population of people in the world live in countries where there is a severe shortage of hygienic potable water. People have to depend directly on groundwater sources like wells, ponds and rivers. Various types of water purification devices that are based on radiation based disinfection, membrane based filtration devices and others like inline and gravity fed devices are also available where it is possible to achieve removal of bacteria, virus and cysts using filtration in combination with biocide action.

In many parts of the world there is shortage of electricity and availability of running water and hence the gravity fed water purifiers which do not require the use of electricity and running water supply have become very popular.

Providing the vitamins and minerals by fortifying water would be very useful and hence devices which can be incorporated into gravity fed water purifiers to deliver known amount of these fortificants would be very useful. In doing this one will have to ensure pure drinking water and at the same time deliver the fortificants.

One main problem in fortifying water with a nutritional amount of vitamins and minerals is that these have a disagreeable aftertaste, change the colour of water and also impart some smell which is objectionable. One will like to have a glass of water without these organoleptic negatives.
It is also a challenge to design a device that will purify water and make it palatable and at the same time deliver the fortificants at a beneficial level.

There have been several attempts to provide water compositions fortified with vitamins and minerals while keeping in mind the need for making it free of objectionable colour, odour and taste.

US 2004/0026451 A1 (Charles H. Jones), discloses, a system of dispensing beverages using water as a motive force and a venturi mixing device to mix the water with a beverage base to produce a beverage output. Here venturi is used as a mixing chamber to mix the 3 streams entering inside the device. Every input stream comprises one valve between the additive storage and venturi mixing device.

US2005258082 A1 (PUR Water Purification Products INC, 2005), discloses a water filtration system, comprising a water inlet connectable to an unfiltered water source, a water filter in fluid communication with the water filter operable to dispense filtered water and an additive dispensing system comprising a reservoir for containing an additive and an additive outlet, wherein the additive dispensing system is operable to selectively dispense an additive to water filtered by the filter. The system requires the use of a controller which is a pump, pneumatic or microprocessor device which controls the amount of additive dispensed. It also discloses that the additive outlet and outlet for water are configured to produce a venturi suction effect.

In such a case as the level of the source water in the chamber decreases the flow of water in the venturi will decrease and there will be a variation in the amount of dosing of the additive.

US7650830 B1 (Miracle Spring LLC, 2010), discloses, a system and method for the enhancement or fortification of a potable fluid. The system is adapted to fit
on existing supplies of potable fluids, such as faucets, to permit the selective introduction of beneficiating materials into the liquid supply.

The system includes interchangeable, replaceable cartridges. The system may also include a water filtration device that may be operated either independently or cooperatively with the system. It is mentioned that a bladder in the cartridge configured to contain quantity of an enhancement ingredient and the pressure from the water causes volume reduction of bladder which aids in dispensing of the ingredient.

WO2011151157 A1 (Unilever) discloses a fortificant dispensing device that is also suitable for use in a gravity fed water purification device so as to provide pure drinking water that is fortified with a fortificant without having the negatives of colour, taste and odour. This device is positioned within the water storage chamber and releases the fortificant into the water therein. This device does not require any external energy like electric power, by which known amounts of fortificants can be dosed into water.

By having the fortificant dosing device attached to the outlet of a source of water it is possible to dose the fortificant as and when the water is dispensed. This ensures the right amount of fortificants is dispensed into the water which is controlled by the volume of water dispensed and also the duration for which the fortified water is stored is minimal. It is possible to dispense quantities of water that one desires to consume and that volume can be appropriately fortified.

This also prevents fortifying large volumes of water and storing them for a long time. Thus, microbial contamination of fortified water, if any, is minimized. This also avoids the contact of the dosing device with any part of the water storage vessel thus improving the hygienic storage of water.

The present inventors have designed a fortificant dosing device that can be fitted to a faucet of a water storage chamber where by providing mechanical
flow control means have been able to dispense proportional amounts of fortificants to suitably fortify the unit amount of water that is dispensed and this also takes care of any variation in the flow rate of water that may result because of the head of water in the storage chamber.

The fortificant dosing device when fitted onto the faucet of a purified water container of any water purification system and especially a gravity fed water purification device can provide a known amount of the fortificant to the water that has been made microbiologically safe and suitable for human consumption. As the gravity fed water purification devices and the fortificant dosing device do not require electric power or running water, it will be possible to provide microbiologically safe water and at the same time provide beneficial amounts of fortificants by an economical and convenient way and without imparting any organoleptic negatives such as colour, taste or odour.

The present inventors have also been able to provide a method for fortifying water for human consumption with beneficial amounts of fortificants such as vitamins, minerals, electrolytes etc by an economical and convenient way and without imparting any organoleptic negatives such as colour, taste or odour.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a fortificant dosing device fitted to a faucet that can fortify the actual amounts of water that is dispensed from the faucet and ready for consumption, thus avoiding the requirement of hygienic storage of fortified water.

It is another object of the present invention to provide beneficial amounts of fortificants through drinking water that is dispensed from a faucet ensuring known and uniform amount of fortificants e.g. 10 to 20% RDA/litre of water are made available in every unit of water that is dispensed.
It is yet another object of the present invention to provide beneficial amounts of fortificants through drinking water ensuring that the water is free of colour, taste and odour.

It is yet another object of the present invention to provide a fortificant dosing device to be fitted to the faucet of a gravity fed water purification device. It is yet another object of the present invention to provide a method of fortifying drinking water that is dispensed from a faucet with beneficial fortificants such as vitamins, minerals and electrolytes at 10-20% RDA without affecting the organoleptic properties of water such as colour, taste and odour.

SUMMARY OF THE INVENTION

According to a first aspect there is provided a liquid fortificant dosing device connectable to an outlet faucet (8) of a water storage chamber (9) having:

(i) a dispensing unit (1) suitable for having a fortificant stock solution having a viscosity in the range of 50 to 2000 cP, said unit having an opening (2) to the atmosphere positioned above the level of said solution;

(ii) a differential pressure unit (3), having an inlet port (4) connectable to said faucet, and an outlet port (5) to dispense fortified water;

(iii) a dosing tube (7) having a diameter in the range of 0.5 to 3 mm connected at one end to the point of minimum pressure (6) of said differential pressure unit while the other end of the dosing tube dips into said solution;

wherein a vent (10) is provided to the atmosphere upstream of said point of minimum pressure in said differential pressure unit and wherein flow rate of water through said faucet is controlled to a substantially constant rate by a mechanical flow control element (11) that is positioned upstream the differential pressure unit (3).
It is preferred that the dispensing unit (1) has a fortificant stock solution having a viscosity in the range of 50 to 2000 cP.

According to a second aspect there is provided a method for fortification of water by the liquid fortificant dosing device of the invention comprising the steps of:

(i) opening the faucet to initiate flow of water through the differential pressure unit;
(ii) creating a suction pressure at the point of minimum pressure in the differential pressure unit;
(iii) releasing the fortificant having a viscosity in the range of 50 to 2000 cP from the dispensing unit into the differential pressure unit through a dosing tube;
(iv) mixing of the water and the fortificant in the differential pressure unit;
and,
(v) collecting the fortified water at the outlet port.

According to a preferred aspect of the present invention there is provided a liquid fortificant dosing device connectable to an outlet faucet of a gravity fed water purification system comprising a filtration unit adapted to filter particulate material, and a chemical purifying unit containing a chemical purifying agent, in which the chemical purifying unit is housed in a sealed chamber and is in fluid communication with the filtration unit such that water treated by the filtration unit is then gravity fed into the chemical purifying unit and retained therein for a predetermined period, after which the water exits the system via a scavenger means which is adapted to recover leached chemical purifying agent.
DETAILED DESCRIPTION

These and other aspects, features and advantages will become apparent to those of ordinary skill in the art from a reading of the following detailed description and the appended claims.

The invention provides for a liquid fortificant dosing device connectable to an outlet faucet of a water storage chamber. The chamber may be a vessel where water from any source may be stored, but the water is preferably purified water. By purified water is meant water that is potable and fit for human consumption. Different criteria are mandated by various health authorities to define potable water. World Health Organisation (WHO) recommends that the water purification system that is used to purify water is capable of 6-log removal of bacteria, 4-log removal of virus and 3-log removal of cysts. The water storage chamber may be part of a table top storage type water purification system or a chamber where water from an online water purification system has been collected and stored for use by a consumer.

The liquid fortificant dosing device includes a dispensing unit which is suitable for having a fortificant stock solution. The fortificant stock solution, as per the present invention has a viscosity in the range of 50 to 2000 cP, preferably 100 to 1000 cP and still more preferably 100 to 300 cP measured at 20 sec⁻¹. This narrow viscosity range is important to ensure that the opposing forces of suction and friction are balanced such that the dosing concentration into the flowing stream of water is in the desired narrow range. The fortificant stock solution is usually prepared by mixing the desired fortificant in water along with a viscosity enhancing agent. Various fortificants can be included in the fortificant stock solution for dosing into water using the device of the invention.
Preferred fortificants to be dosed by the device according to the invention may be selected from one or more of a vitamin, mineral, electrolyte, flavor or nutrient. They may be either from a chemical or a natural source. According to a highly preferred aspect of the present invention, a natural source of vitamin and mineral is *Phyllanthus emblica* (Amla) extract.

Amla primarily contains tannins, bioflavonoids, carotenoids, alkaloids, and phenolic compounds, amino acids and carbohydrates which have extraordinary longevity and rejuvenating properties. Synthetic vitamin C does not provide vital nutrients such as rutin and bioflavonoids. Amla is valued for its unique tannins and flavonoids, which exhibit very powerful antioxidant properties. Amla is considered as a more potent antioxidant than vitamin C. Vitamin C in Amla accounts for -45 to 70% of the antioxidant activity. There are no RDA levels for Amla. The present inventors have determined that it is beneficial to dose it in a range between 2 to 50 ppm and preferably between 5 and 10 ppm since at concentrations more than 10 ppm, the fortified water is likely to get slightly coloured. It is preferred that we dose the vitamins and minerals at 10 to 20% of the Recommended Daily Allowance (RDA) per liter of water. The dosage of these fortificants is selected such that it does not impart any negative organoleptic property to the water.

Water may also be fortified with iron using the device of the invention. Iron compounds which may be dosed include a water-soluble iron compound, a water-dispersible particulate iron compound, or mixtures thereof. In addition, the iron compound of the present invention is preferably selected from a complexed iron compound, a chelated iron compound, an encapsulated iron compound, or mixtures thereof. Highly bioavailable iron compound is preferably chosen to provide maximum health benefits.

Iron-fortified water usually suffers from a metallic taste / aftertaste. The elimination of the metallic taste can be achieved by encapsulating the iron
compound. The metallic taste can also be eliminated by binding the iron into a stable compound by complexing or chelating with a suitable ligand that does not permit the iron to be freely associated in water. Preferred iron compound forms also include encapsulates and complexes that preferably have a dispersed particle size in the water that is small enough to be barely visible in solution. Preferably, the dispersed particle size is about 100 nm or less, and more preferably about 80 nm or less.

Ferrous iron is typically better utilized by the body than ferric iron. Ferrous amino acid chelates are particularly suitable as highly bioavailable forms when the ligand to metal ratio is at least 2:1.

Highly bioavailable food grade ferrous salts that can be used in the present invention include ferrous sulphate, ferrous fumarate, ferrous succinate, ferrous gluconate, ferrous lactate, ferrous tartarate, ferrous citrate, ferrous amino acid chelates, as well as mixtures of these ferrous salts. Certain ferric salts can also provide a highly bioavailable source of iron. Highly bioavailable food grade ferric salts are ferric saccharate, ferric ammonium citrate, ferric citrate, ferric sulfate, ferric chloride, as well as mixtures of these ferric salts. Other bioavailable sources of iron particularly suitable for fortifying water of the present invention include certain iron-sugar-carboxylate complexes. In these iron-sugar-carboxylate complexes, the carboxylate provides the counter ion for the ferrous (preferred) or ferric iron.

The USRDA for iron generally ranges from 10 mg per 6 kg for females or males to 18 mg per 54 to 58 kg for females, depending somewhat on age. The iron fortified water prepared using the device of the present invention typically contains at least about 1 ppm of iron compound, sufficient to deliver about 10% of USRDA of iron per liter of water to account for iron that is available from other dietary sources, assuming a reasonably balanced diet is available.

The water compositions of the present invention can contain nutrients, for example vitamin C, vitamin E, vitamin A, niacin, vitamin B6, vitamin B2, vitamin
D2, vitamin B12, folate, zinc, electrolytes such as salts of sodium, potassium or magnesium and mixtures thereof. The typical values for most healthy adults are generally: vitamin C (60 mg), vitamin A (2000 IU/day) vitamin B2 (1.7 mg), niacin (20 mg), vitamin B6 (2.0 mg), folic acid (0.2 mg/day), vitamin D2 (400 IU/day), vitamin B12 (0.001 mg/day) magnesium (300 mg), zinc (11 mg/day) and vitamin E (30 international units). The adequate intake value of sodium is generally 1.5 g and for potassium is generally 4.7 g.

Commercially available sources of vitamin C may be used herein. Encapsulated ascorbic acid and edible salts of ascorbic acid may also be used. Commercially available vitamin A sources may also be incorporated into the water composition. Vitamin A can be provided, for example, as vitamin A palmitate (retinol palmitate), vitamin A acetate and/or as beta-carotene. It can be as an oil, as a beadlet or may be encapsulated. As used herein, "vitamin A" includes vitamin A, β-carotene, retinol palmitate and retinol acetate. Commercially available sources of vitamin B2 (riboflavin) can be used herein. Nutritionally supplemental amounts of other vitamins for incorporation into the water include, but are not limited to, vitamins B6 and B12, folate, niacin and vitamins D2 (ergocalciferol) and vitamin E. Preferred salt for vitamin B12 is 5,6 DNB cyanocobalamide and for folate is folic acid. Sodium salts can be selected from sodium chloride, sodium ascorbate, sodium citrate, sodium ferric pyrophosphate, sodium gluconate, sodium phosphate, sodium pyrophosphate or mixtures thereof.

Potassium salts can be selected from potassium chloride, potassium gluconate, potassium glycerophosphate, potassium iodide or mixtures thereof. Magnesium salts can be selected from magnesium gluconate, magnesium phosphate, magnesium sulfate or mixtures thereof. Zinc salts can be selected from zinc oxide, zinc gluconate, zinc sulfate or mixtures thereof.
Preferably, the water prepared using the device of the invention contains at least 5%, preferably 10-20% of the USRDA or adequate intake value for these vitamins, minerals or electrolytes. Other vitamins, minerals and electrolytes can also be incorporated into the water depending on the nutritional needs of the consumers to which the water product is directed.

Disclosed composition may optionally comprise a sweetener. Such sweetening agents are added to the water to mask a metallic taste or after-taste caused by the minerals or vitamins. Suitable particulate sugars can be granulated or powdered, and can include sucrose, fructose, dextrose, maltose, corn maltodextrin, lactose and mixtures thereof. Most preferred is sucrose. Artificial sweeteners may also be used. Often gums, pectins and other thickeners are used with artificial sweeteners. Mixtures of sugars and artificial sweeteners may also be used.

The viscosity of the fortificant stock solution in the desired range is higher than that of water and this is attained by including a viscosity enhancing agent in water. Preferred viscosity enhancing agent is selected from a viscosifier, thickener, emulsifier, stabilizer or gelling agent. The viscosity enhancing agent is preferably present in the range of 0.0001 to 50% by weight of the fortificant stock solution more preferably in the range of 0.0001 to 10% by weight of the solution. Examples of suitable viscosity enhancing agents are hydrocolloid, polysaccharide, pectins, casein, salts and glycerol esters of fatty acids, glycerol esters of wood resin, polysorbates or mixtures thereof.

The dispensing unit suitable for comprising the fortificant stock solution having viscosity in the range of 50 to 2000 cP is usually cylindrical in shape but other suitable shapes may also be used. The dispensing unit preferably includes a solution inlet at the top to which a container having the fortificant stock solution is connectable in an inverted dispensing configuration.
The solution inlet is preferably a circular port at the top of the dispensing unit to which a container having fresh fortificant stock solution may be connected in an inverted configuration for leak-tight dispensing of fresh fortificant stock solution. The fortificant stock solution may be replenished in the dispensing unit from time to time, as desired, using fresh stock solution from such a container.

It is an important aspect of the present invention that the dispensing unit has an opening to the atmosphere above the maximum attainable solution level. The opening is preferably on the top surface of the dispensing unit. The opening is preferably cylindrical in shape although any other suitable cross section may be used. The opening is preferably provided with a filter, preferably an air filter, to minimize ingress of dust and other contaminants from the atmosphere into the fortificant stock solution. The filter preferably has a pore size in the range of 0.05 to 1 \( \mu m \), more preferably the pore size is in the range of 0.1 to 1 \( \mu m \). It has been observed that if this opening is not provided in the dispensing unit as claimed, the desired amount of fortificant stock solution dosed into the water is not consistent over time especially when the level of the fortificant changes over the course of use.

The fortificant dosing device includes a differential pressure unit, having an inlet port connectable to the faucet and an outlet port to dispense fortified water. The differential pressure unit is preferably a venturi. It is preferably not horizontally configured and as per a highly preferred aspect, it is vertically aligned. Preferred shapes of the differential pressure unit are to have the inlet port, the outlet port and the point of minimum pressure to be circular. Preferred dimensions are as follows for the leading dimensions of the various features: Inlet port: 4 to 8 mm, outlet port 4 to 8 mm, point of minimum pressure 2 to 5 mm. The differential pressure unit is operational by ensuring that dimensions of the point of minimum pressure are smaller than the dimensions of the inlet and outlet ports.
To transfer the fortificant stock solution from the dispensing unit to the running water, a dosing tube having an inner diameter in the range of 0.5 to 3 mm, preferably in the range of 0.5 to 1.5 mm is connected at one end to the point of minimum pressure of the differential pressure unit while the other end of the dosing tube dips into the fortificant solution in the dispensing unit. The length of the dosing tube is preferably from 5 to 50 mm, more preferably from 5 to 15 mm. The inner surfaces of the dispensing unit and the dosing tube are preferably lined with a hydrophobic material selected from ultra-low surface energy materials or ultra-hydrophobic surfaces containing highly refined surface micro-textures or nano-textures.

It is an important aspect of the present invention to provide a vent to the atmosphere upstream of the point of minimum pressure in the differential pressure unit. It has been found by extensive experimentation that the undesired phenomenon of back flow of the fortificant stock solution from the point of minimum pressure in the pressure differential unit to the dispensing unit is minimized, especially during the unsteady state flow/pressure conditions that occur during shut-off or start of flow of water, by providing such a vent.

Another important aspect of the present invention is controlling the flow rate of water through the faucet to a substantially constant rate by using a mechanical flow control element that is positioned upstream of the differential pressure unit. The mechanical flow control element has advantages over electronic elements in its simplicity of operation and maintenance which are important factors in using such devices in remote villages where such devices are likely to be used. Also, mechanical flow control devices, unlike the electronic ones, do not require continuous supply of power and so can be used to deliver fortified water in remote areas which often suffer from inconsistent supply of continuous electricity. Preferred mechanical flow control elements are a float valve or a spring controlled valve.
A float valve preferably comprises a float that detects the level of water, which is connected to a lever that mechanically actuates a valve for control of the flow of water.

Another mechanical flow control element that may be used is a spring controlled valve which includes a spring positioned in the stream of water that is stretched or contracted based on the flow rate of water that causes movement of a cone into an orifice, all of these elements are arranged in mutually coaxial configuration, to control the flow rate of water.

It is observed that for fortification of water dispensed through a faucet of a tabletop water storage chamber, the preferred flow rates of water are in the range of 100 to 1200 ml/minute.

According to a preferred aspect of the invention the device is connected to the outlet faucet of water purification system. The water purification system may include purification processes selected from filtration, use of biocide like halogen based biocides, biocidal action using UV (ultra violet radiation), ozonisation, ultrafiltration, reverse osmosis or combination of two or more of the above processes. The faucet is preferably connected to a water storage chamber of a gravity fed water purification system. It is especially useful to connect the device to the outlet faucet of the gravity fed water purification device disclosed in WO04000732 A1 (Unilever). Disclosed therein is a gravity fed water purification system having a filtration unit adapted to filter particulate material, and a chemical purifying unit containing a chemical purifying agent, in which the chemical purifying unit is housed in a sealed chamber and is in fluid communication with the filtration unit such that water treated by the filtration unit is then gravity fed into the chemical purifying unit and retained therein for a predetermined period, after which the water exits the system via a scavenger means which is adapted to recover leached chemical purifying agent.
According to a second aspect of the present invention there is provided a method for fortification of water by the liquid fortificant dosing device of the first aspect comprising the steps of:

(i) opening the faucet to initiate flow of water through the differential pressure unit;

(ii) creating a suction pressure at the point of minimum pressure in the differential pressure unit;

(iii) releasing the fortificant having a viscosity in the range of 50 to 2000 cP from the dispensing chamber into the differential pressure unit through said dosing tube;

(iv) mixing of the water and the fortificant in the differential pressure unit; and,

(v) collecting the fortified water at said outlet port.

It is to be noted that the examples/figures given in the description below are intended to clarify the invention and are not intended to limit the invention to those embodiments *perse*.

**BRIEF DESCRIPTION OF THE FIGURES**

Figure 1 is a sectional view of an embodiment of the fortificant dosing device in accordance with the present invention wherein the flow control element is a float valve.

Figure 2 is a sectional view of an embodiment of the fortificant dosing device in accordance with the present invention wherein the flow control element is a spring controlled valve.
Figure 3 is a sectional view of another embodiment of the fortificant dosing device in accordance with the present invention wherein the flow control element is a spring controlled valve.

Figure 4 is a sectional view of another embodiment of the fortificant dosing device in accordance with the present invention wherein the flow control element is a float valve with a specific configuration of the dosing tube.

DETAILED DESCRIPTION OF THE FIGURES

Figure 1 is a sectional view of an embodiment of the fortificant dosing device fitted to a faucet of a water storage chamber in accordance with the present invention wherein the flow control element is a float valve. The fortificant dosing device has a container (21) comprising the fortificant stock solution having a viscosity in the range of 50 to 2000 cP and in fluid communication with a dispensing unit (1) provided with an opening (2) to maintain the unit at atmospheric pressure. The differential pressure unit (3) is provided with an inlet (4) and outlet port (5), the inlet port is connected to the faucet (8) of the water storage chamber (9). The differential pressure unit (3) is connected to the dispensing unit (1) at the point of minimum pressure (6) by means of a dosing tube (7). A vent (10) is provided above the differential pressure unit to maintain the unit at atmospheric pressure and is in fluid communication with the outlet port (5) of the differential pressure unit. The flow of water from the storage chamber (9) through the faucet (8) is controlled by a mechanical flow control element (11) that is positioned inside the storage chamber.

The flow control element (11) that is positioned inside the storage chamber (9) has a float (12), a lever (13) and a valve (14) comprising a needle (15) and two orifices (16 and 17).
The needle (15) is placed perpendicular to the lever and the tip of the needle moves inside the orifice (16) such that the orifice is either closed or partially opened depending upon the position of the float, which in turn depends on the level of water in the storage chamber (9). Hence the total area of the orifice available for flow of water increases with decreasing level of water in storage chamber. The other orifice (17) is always maintained in open condition. This configuration of the mechanical flow control element ensures substantially constant flow rate of water irrespective of the head of water available in the water storage chamber.

Figure 2 shows a sectional view of an embodiment of the fortificant dosing device provided with a spring controlled valve as the flow control element (11). The spring controlled valve is positioned after the faucet (8) and comprises of a cone (18), which moves inside a coaxially positioned orifice (19), whose movement is controlled by a spring (20). The effective open area of the orifice is controlled by the resultant force exerted as a result of two opposing forces (i) in the downstream direction by the kinetic energy of the water and (ii) the force on the cone exerted by the potential energy present in the spring in the opposite direction. The cone thus achieves a position in the orifice where the opening of the orifice has an inverse relationship to the height of water in the storage chamber, thus facilitating substantially constant flow rate of water through the differential pressure unit.

Figure 3 is a sectional view of an embodiment where the length of dosing tube (7) in Figure 4 is shorter than the one in that of Figure 3.

Figure 4 is a sectional view of an embodiment where the dosing tube (7) is a 'L' shaped tube with one end of it dipped inside the fortificant stock solution of the dispensing unit and the other end is in connected to the differential pressure unit (3) at the point of minimum pressure (6). The other features of this embodiment are as described in Figure 1.
When in use, in any of the embodiments of Figures 1 to 4, when faucet (8) is opened, water from the water storage chamber (9) flows through the inlet (4) of the pressure differential unit (3), due to the mechanical flow control element (11), irrespective of the head of water in the chamber (9). As the water flows through the point of minimum pressure (6) the fortificant stock solution is sucked in through dosing tube (7) from the dispensing unit (1) to mix therein and is dispensed out of the faucet through outlet port (5), thereby providing water with a controlled amount of fortificant. The vent (10) provided upstream of point of minimum pressure in said differential pressure unit brings the pressure inside the differential pressure unit (3) to atmospheric pressure immediately after the faucet is closed. The small volume of water present in the differential pressure unit drains out due to gravity.

In case where no vent was provided and the faucet was closed after the dosing cycle, it was observed that the small volume of water remaining in the differential pressure unit (3) was pulled towards the point of minimum pressure (6) and eventually entered into the fortificant solution through the dosing tube (7) thereby reducing viscosity of the fortificant solution. This phenomenon was observed because the pressure inside the differential pressure unit was lower than the atmospheric pressure. This in turn increased the dosage of the fortificant in fortified water in the next dosing cycle. Thus it is essential to provide the vent for achieving uniform dosing of the fortificant.

The invention will now be demonstrated with examples. The examples are by way of illustration only and do not limit the scope of the invention in any manner. The superior performance of the dosing device of the invention is demonstrated with the following data.
EXAMPLES

Procedure for making the fortificant mix

The amount of the fortificants as mentioned in Table 1a and 1b below were added to 100 ml of microbiologically purified water and mixed well. The viscosity of the fortificant solution was adjusted by addition of a suitable amount (0.4 gram) of a viscosifier i.e. Xanthan gum to the fortificant solution. 1 g of sodium chloride was added to 100 ml of fortificant solution to stabilise the viscosity.

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Source</th>
<th>Amount of mg of micronutrient added to 100 ml water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Vitamin A acetate CWS</td>
<td>923</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>5,6 DMB cyanocobalamide</td>
<td>15</td>
</tr>
<tr>
<td>Vitamin D2 (Ergocalciferol)</td>
<td>Vitamin D2 (100) powder</td>
<td>600</td>
</tr>
<tr>
<td>Folate</td>
<td>Folic acid</td>
<td>30</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zinc gluconate</td>
<td>9122</td>
</tr>
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Table 1b: Fortificant solution composition 2

<table>
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<tr>
<th>Micronutrient</th>
<th>Source</th>
<th>Amount of mg of micronutrient added to 100 ml water</th>
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<tr>
<td>Vitamin A</td>
<td>Vitamin A (added as Vitamin A Palmitate 1.7 ml IU/g)</td>
<td>228</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Vitamin B12 (Vitamin B12 1% on Mannitol)</td>
<td>17</td>
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<tr>
<td>Vitamin D2 (ergocalciferol)</td>
<td>Vitamin D2 (added as Vitamin D2 5ml IC/g)</td>
<td>6</td>
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<tr>
<td>Zinc</td>
<td>Zinc (D-gluconic acid zinc salt hydrate half quantity)</td>
<td>935</td>
</tr>
</tbody>
</table>
Examples 1 and 2: Effect of dosing of fortificant by maintaining the dispensing unit at atmospheric pressure as compared to using a sealed chamber.

A device as described in figure 1 with the dosing tube diameter of 1.7 mm was used to determine the dosing of fortificants (composition as mentioned in Table 1a, xanthan gum as viscosifier = 0.4 % (viscosity of fortificant solution = 260 cP at 20 s⁻¹) and to determine the benefit of keeping the dosing chamber at atmospheric pressure. Hundred mg of Rhodamine B dye was added to 100 ml of fortificant solution and was mixed well. The fortificant solution was then poured into the dispensing unit. One litre of water was passed through the faucet at various heads as indicated in Table 2. The output water was analysed for the concentration of the dye by measuring the absorbance using a UV spectrophotometer at 553 nm.

A separate set of experiment was conducted at the same conditions as above but while not keeping the dispensing unit at atmospheric pressure (using a sealed unit) and the results are presented in Table 3.

Example - 1: Fortificant dosing at different water heads of storage chamber when dispensing unit is at atmospheric pressure.

<table>
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<tr>
<th>Volume of water in storage chamber/litres</th>
<th>Water</th>
<th>Absorbance at 553 nm</th>
<th>Concentration of fortificant in water/ppm</th>
<th>Dosage of fortificant (ml/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
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<td>0.1701</td>
<td>0.8</td>
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<td>6</td>
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<td>0.3481</td>
<td>1.64</td>
<td>2.21</td>
</tr>
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<td>14</td>
<td>0.2892</td>
<td>1.36</td>
<td>1.83</td>
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<td>0.88</td>
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<td>0.95</td>
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<tr>
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<td>5.8</td>
<td>0.1701</td>
<td>0.8</td>
<td>1.08</td>
</tr>
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</table>
Example - 2: Fortificant dosing at different water heads of storage chamber when dispensing unit is not at atmospheric pressure.

Table 3

<table>
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<tr>
<th>Volume of water in storage chamber/litres</th>
<th>Water</th>
<th>Absorbance at 553 nm</th>
<th>Concentration of fortificant in water/ppm</th>
<th>Dosage of fortificant (ml/l)</th>
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</thead>
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<td>7</td>
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<td>0.08</td>
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<tr>
<td>6</td>
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<td>3</td>
<td>8.6</td>
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<tr>
<td>2</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The data in Table 2 and 3 indicates the significant advantage achieved in including an opening to the atmosphere in the dispensing unit.

Examples 3 and 4: Dosing of fortificant in presence and absence of flow control element

A unit as in figure 1 with the dosing tube diameter of 1.7 mm was used to determine the dosing of fortificants (composition as mentioned in Table 1a, xanthan gum as viscosifier = 0.55% (viscosity of fortificant solution = 4.15 cP at 20 s⁻¹) to determine the benefit of including the mechanical flow control element while keeping the dispensing unit at atmospheric pressure. 100 mg of Rhodamine B dye was added to 100 ml of fortificant solution and was mixed well. The fortificant solution was then poured into the dispensing unit. 1 liter of water was passed through the unit at various heads as indicated in Table 4. The output water was analysed for the concentration of the dye by measuring the absorbance using a UV spectrophotometer at 553 nm.
The above set of experiments were repeated using the device of figure 1 which had no flow control element included therein and the results are presented in Table 5.

Example 3: Fortificant dosing in presence of flow control element

Table 4

<table>
<thead>
<tr>
<th>Volume of water in storage chamber/litres</th>
<th>Water</th>
<th>Absorbance at 553 nm</th>
<th>Concentration of fortificant in water/ppm</th>
<th>Dosage of fortificant (ml/l)</th>
</tr>
</thead>
<tbody>
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<td>0.82</td>
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<td>0.95</td>
<td>1.28</td>
</tr>
<tr>
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<td>0.2131</td>
<td>1.00</td>
<td>1.35</td>
</tr>
<tr>
<td>3</td>
<td>8.6</td>
<td>0.1089</td>
<td>0.51</td>
<td>0.69</td>
</tr>
<tr>
<td>2</td>
<td>5.8</td>
<td>0.049</td>
<td>0.23</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Example 4: Dosing of fortificant in the absence of flow control element

Table 5

<table>
<thead>
<tr>
<th>Volume of water in storage chamber/litres</th>
<th>Water</th>
<th>Absorbance at 553 nm</th>
<th>Concentration of fortificant in water/ppm</th>
<th>Dosage of fortificant (ml/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>20</td>
<td>1.0322</td>
<td>4.85</td>
<td>6.55</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>0.8193</td>
<td>3.85</td>
<td>5.20</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>0.5585</td>
<td>2.62</td>
<td>3.54</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>0.3396</td>
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<td>2.15</td>
</tr>
<tr>
<td>4</td>
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</tr>
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<td>0.0328</td>
<td>0.15</td>
<td>0.21</td>
</tr>
</tbody>
</table>

The data in tables 4 and 5 indicate the significant advantage in including the flow control element for substantially controlled dosing of fortificants in water.
Example 5: Percentage RDA/litre of water dispensed using a fortificant dosing according to the disclosed invention

A unit as in Figure 1 with the dosing tube diameter of 1.0 mm was used to determine the dosing of fortificants (composition as mentioned in Table 1b, 0.4 g of xanthan gum was added as viscosifier along with 1 g of NaCl (viscosity of fortificant solution = 415 cP at 20 s⁻¹) in terms of %RDA dosing using the fortificant dosing device according to the present invention. 50 mg of Rhodamine B dye was added to 100 ml of fortificant solution and was mixed well. The fortificant solution was then poured into the dispensing unit. 1 litre of water was passed through the unit at various heads as indicated in Table 6. The output water was analysed for the concentration of the dye by measuring the absorbance using a UV spectrophotometer at 553 nm.

Table 6

<table>
<thead>
<tr>
<th>Volume of water in the storage chamber/litres</th>
<th>Water head cm</th>
<th>Absorbance at 553 nm</th>
<th>Dosage of multivitamin (ml/litre)</th>
<th>% RDA of micronutrient in 1 litre of water</th>
</tr>
</thead>
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<tr>
<td>8</td>
<td>20</td>
<td>0.0096</td>
<td>0.1</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>0.0093</td>
<td>0.1</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>0.0082</td>
<td>0.09</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>0.0083</td>
<td>0.09</td>
<td>13</td>
</tr>
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<td>11</td>
<td>0.0081</td>
<td>0.09</td>
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<td>3</td>
<td>8</td>
<td>0.0082</td>
<td>0.09</td>
<td>13</td>
</tr>
</tbody>
</table>

The data in tables 6 indicates that using the fortificant dosing device of the present invention provides the desired range of 10-20% RDA/Litre of water irrespective of the water head in the storage chamber. The water dispensed from the device according to the present invention uniformly provides the required 10-20% RDA/Litre of water.
The disclosed invention provides a fortificant dosing device connectable to an outlet faucet that can provide purified potable water and at the same time provide beneficial amounts of fortificants e.g. 10 to 20% RDA/Litre of water are made available in every unit of water that is dispensed.
Claims

1. A liquid fortificant dosing device connectable to an outlet faucet (8) of a water storage chamber (9) comprising:
   (i) a dispensing unit (1) suitable for comprising fortificant stock solution having a viscosity in the range of 50 to 2000 cP, said unit having an opening (2) to the atmosphere positioned above the level of said solution;
   (ii) a differential pressure unit (3), comprising an inlet port (4) connectable to said faucet (8), and an outlet port (5) to dispense fortified water;
   (iii) a dosing tube (7) having a diameter in the range of 0.5 to 3 mm connected at one end to the point of minimum pressure (6) of said differential pressure unit (3) while the other end of the dosing tube (7) dips into said solution;
   wherein a vent (10) is provided to the atmosphere upstream of said point of minimum pressure (6) in said differential pressure unit (3) and wherein flow rate of water through said faucet (8) is controlled to a substantially constant rate by a mechanical flow control element (11) that is positioned upstream of the differential pressure unit (3).

2. A device according to claim 1, wherein the dispensing unit (1) comprises a fortificant stock solution having a viscosity in the range of 50 to 2000 cP.

3. A device as claimed in claim 1 or 2 wherein the flow control element (11) is selected from a float valve or a spring controlled valve.

4. A device as claimed in claim 3 wherein the float valve comprises a float (12) connected to a lever (13) and a valve (14).
5. A device as claimed in claim 3 or 4 wherein the spring controlled valve comprises a cone (18), an orifice (19) and a spring (20) arranged in mutually coaxial configuration.

6. A device as claimed in any one of the preceding claims, wherein the differential pressure unit (3) is vertically aligned.

7. A device as claimed in any one of the preceding claims wherein the dispensing unit (1) comprises a solution inlet at the top to which a container (21) comprising the fortificant stock solution is connectable in an inverted dispensing configuration.

8. A device as claimed in any one of the preceding claims, wherein the fortificant is selected from a vitamin, mineral, electrolyte, flavour or nutrient.

9. A device as claimed in any one of the preceding claims, wherein the viscosity of the fortificant stock solution is attained by including a viscosity enhancing agent selected from a viscosifier, thickener, emulsifier, stabilizer or gelling agent in the range of 0.0001 to 50% by weight of the solution.

10. A device as claimed in claim 9, wherein the viscosity of the fortificant stock solution is attained by including a viscosity enhancing agent selected from a viscosifier, thickener, emulsifier, stabilizer or gelling agent in the range of 0.0001 to 10% by weight of the solution.

11. A device as claimed in any one of the preceding claims wherein the viscosity enhancing agent is selected from a hydrocolloid, polysaccharide, pectins, casein, salts and glycerol esters of fatty acids, glycerol esters of wood resin, polysorbates or mixtures thereof.
12. A device as claimed in any one of the preceding claims wherein the opening on the dispensing unit is provided with a filter.

13. A device as claimed in claim 12 wherein the filter has a pore size in the range 0.1 to 1 micron.

14. A device as claimed in any one of the preceding claims wherein the inner surfaces of the dispensing unit and the dosing tube is lined with a hydrophobic material selected from ultra low surface energy materials or ultra hydrophobic surfaces containing highly refined surface micro textures or nano textures.

15. A device as claimed in any one of the preceding claims wherein said device is connected to an outlet faucet of a gravity fed water purification system comprising a filtration unit adapted to filter particulate material, and a chemical purifying unit containing a chemical purifying agent, in which the chemical purifying unit is housed in a sealed chamber and is in fluid communication with the filtration unit such that water treated by the filtration unit is then gravity fed into the chemical purifying unit and retained therein for a predetermined period, after which the water exits the system via a scavenger means which is adapted to recover leached chemical purifying agent.
16. A method for fortification of water by the liquid fortificant dosing device as claimed in any one of the preceding claims comprising the steps of:

(i) opening the faucet (8) to initiate flow of water through the differential pressure unit (3);

(ii) creating a suction pressure at the point of minimum pressure (6) in the differential pressure unit (3);

(iii) releasing the fortificant having a viscosity in the range of 50 to 2000 cP from the dispensing unit (1) into the differential pressure unit (3) through a dosing tube (7);

(iv) mixing of the water and the fortificant in the differential pressure unit (3); and

(v) collecting the fortified water at said outlet port (5).
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/EP2012/069517

### A. CLASSIFICATION OF SUBJECT MATTER

**INV. C02F1/68**

**ADD.**

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

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- C02F

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)

- EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<td>DE 16 67 157 Al (LANG APPBAU GMBH &amp; CO KG) 9 June 1971 (1971-06-09) page 7, paragraph 2; claims 1-7; figure 1</td>
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</table>

Further documents are listed in the continuation of Box C.

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
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- "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

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*"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

*"A" document member of the same patent family

**Date of the actual completion of the international search**

10 December 2012

**Date of mailing of the international search report**

18/12/2012

**Name and mailing address of the ISA**

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Oenhausen, Chr. audi a
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