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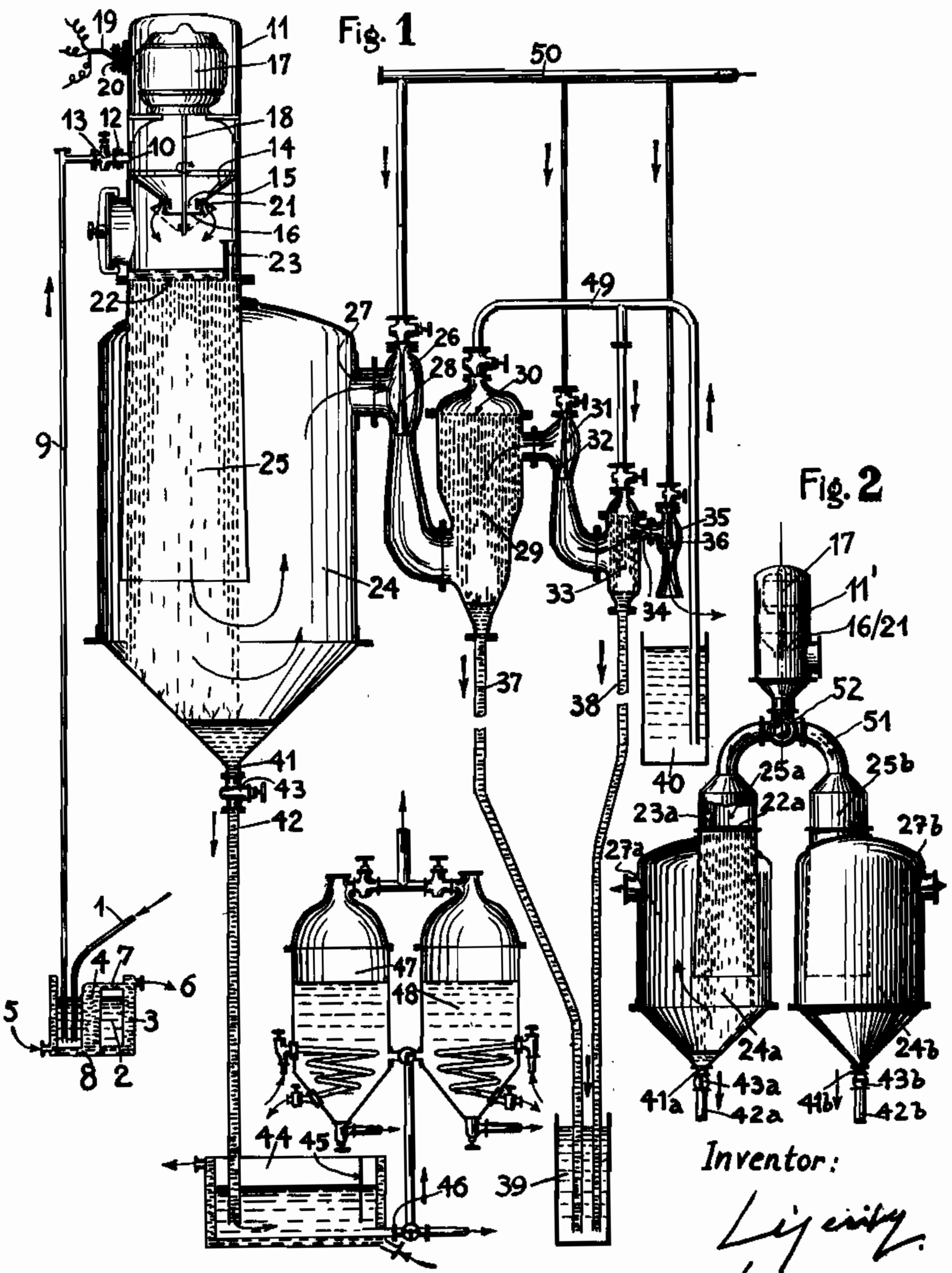

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METHOD AND APPARATUS FOR THE FERMENTATIONLESS CONSERVATION OF FRUIT-, GRAPE-, AND GREENS-JUICES

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The present invention relates to a method and an apparatus for the fermentationless conservation of fruit-, grape- and greens-juices.

As a well known disadvantage, conserved fruit-, grape- and greens juices as usually on the market have another flavour and odour as the freshly squeezed juices. However, it has not been possible hitherto to conserve these juices and to bottle them without previously treating them in a determined manner. The known proceedings hitherto used result in an alteration of the flavour and odour of the juice, owing to the fact that as soon as during the treatment symptoms of a fermentation turn up, the first chemical reactions caused by the cells of yeast modify certain original combinations of the juice, causing in this manner a detrimental alteration of the flavour and odour of the freshly squeezed juice.

It is further to be noted that during the prosecution of certain proceedings—either before the concentration or the bottling, or before the conveying of the juices in conserving tanks, in which they are to be preserved against deterioration by cooling or carbonic acid under pressure—a determined period of time is elapsing during which the juices are undergoing a fermentation, as f. i. at the clarifying, the filtration and sometimes at the ultra-filtration of the juices.

In several countries, it is also admitted to use chemicals in order to prevent formation of iron or copper containing precipitations and to effectuate the clarification of the juices, but such chemicals are of a destroying effect to the sensitive vitamins of the juices. Other chemicals such as benzoates, the use of which is admitted in several countries, have the typical flavour of pharmaceutical preparations.

By using sulphuric acid and potassium metabisulphite which are also admitted in several countries, the vitamins are equally destroyed and a disagreable sulphur smell is produced, since these combinations when brought into the juice, are transforming themselves partly in sulphuric acid and combine with a part of the free sulphur dioxide or with that having been freed by the natural acids of the juice to a combination impossible to be destroyed merely by heat application and decomposition of which by boiling is but very difficult, so that a subsequent desulphuration is rendered very difficult. The combination formed in this manner further undergoes inpresence of the organical substances of the juice and after certain time a decomposition thus producing free sulphuretted hydrogen with its known nauseous odour.

Even with those of the juices in which fermentation could be prevented, it must sometimes be stated that when growing old the flavour and odour of the same is altered. Particularly the juices of fruits from the south, f. i. of oranges, are getting after a relatively short time a mouldy flavour and a slight odour of turpentine.

The juices generally eager for oxide and combinations of which are partly very liable to oxide, absorb oxide or are undergoing alterations during the prosecution of certain treatments or during the heating required for the concentration and stabilisation of the juices, which alterations are producing a partial oxidation. These alterations result in the production of a flavour of stewed fruit or bake and of a cooking odour and—particularly in the fruits from the south,—the creation of a slight turpentine odour. The consumer is perceiving all that as disagreeable and will care any more for conserved juices.

The little quantities of fruit stew and of pulp present in the squeezed juice contain a part of the juice, and with some fruits very savoury components. In fruits from the south, these components also contain essence-oils which are very liable to produce further alterations of the juice as to flavour and odour.

The usual proceedings for the partial separation of these pulp residues etc. require certain time and if the juice is not absolutely prevented from the access of air during this time and if the juice is not enclosed in a vessel of approximately an absolutely vacuum, it is going to oxiding more or less. As far as juice of fruits from the south is concerned, it will thus become stale and dead and will loose the vivacious, pregnant flavour of the freshly squeezed juice.

The inventor has found a number of new fundamental statements which though new are not in contradiction with the fundamental principles fixed by Pasteur that on the one hand the yeast is developed as a result of a large introduction of oxygen, producing but very small quantities of alcohol and carbonic acid and that on the other hand the yeast under normal conditions transforms the sugar almost completely in carbonic acid and alcohol without increasing itself in quantity.

The aforesaid statements are as follows:

1. Fermentation once started accelerates itself, if the liquid is heated to a suitable temperature and contains the substances which are indis-

pensable for the formation of the yeast cells (orthophosphoric acid, nitrogen combinations enabling an assimilation) and which are essential for their biologic functions (sugar and some acid), according to a determined principle. This rapid progression of the fermentation is a result of the increase of the yeast cells by splitting owing to increasing of the temperature close to the optimum as well as due to secretion of a substance caused by the yeast cells, which substance increases the capacity of fermentation of the yeast cells and their vitality and ability of respiration. From this it follows that it is much more difficult to stop a fermentation once initiated than to prevent it.

2. When the liquid in which the yeast cells have infiltrated is absolutely kept out of contact with oxygen, the following will happen: After having consumed their own provision of oxygen, produced the small quantity of alcohol and carbonic dioxide corresponding to their ability and duration of life, and having developed themselves more or less weakly (weakly in consequence of the lack of oxygen), the yeast cells are producing branch cells which apparently have forgotten their descent wholly or partly and seem to be no more able to produce alcohol and carbonic dioxide. However this does not prevent the liquid, when coming in contact with fresh air to undergo an active fermentation according to its nature and to the given conditions of temperature.

3. If the juice immediately after squeezing is extremely cooled down, say close to the freezing point, i. e. to 28,4° Fahrenheit, it results not only a deafening of the yeast cells contained in the juice, but it happens also a partial precipitation of certain combinations which releases by splitting the separation of other elements and consequently initiates clarifying.

4. When the juice is completely freed from oxygen, completely prevented from all possibility of oxydation and simultaneously is sufficiently cooled, formation of the aforesaid alterations of flavour and odour is no longer to be feared, and they will not appear neither in the moment nor later, nor under the influence of a moderate heating of a relatively short duration.

5. When a liquid containing absorbed gases is subjected to vacuum and when this vacuum is corresponding to the absolute pressure under which the liquid at the temperature which it possesses begins to boil, the gases absorbed by the liquid are expelled under the condition that the vapours produced by boiling are continually sucked off. The temperature of the liquid drops under the influence of the evaporation which the liquid is subjected to.

The result would not be the same when the produced vapours were not continually sucked off, since when the pressure of the vapours reaches the absolute pressure under which the liquid at the prevailing temperature begins to boil, boiling of the liquid and consequently expelling expelling of the gases would cease.

6. When at a temperature somewhat below the value at which the yeast cells are destroyed the liquid is subjected to a vacuum that corresponds to the absolute pressure under which the liquid at the prevailing temperature begins to boil, it may be noted that the yeast cells resist to this temperature so effectively as when subjected to it at standard barometrical height of 30 inch of mercury. In consequence, time of heating may be shortened and temperature of sterilisation reduced. Owing to the complete desoxydation of the juice in combination with cooling down to solidification of the liquid, the use of antiseptica, of anti-fermenting means and of chemical substances which are to help clarifying or to retard fermentation, may be dispensed with.

It is, therefore, no longer to fear that immediately or later on alterations of flavour and odour may take place. There is further no more danger of slow oxydation on storing the juices in tanks kept cool or under carbonic dioxide (the carbonic dioxide is not able, even when it may paralyze the yeast cells, to prevent the action of the dissolved oxygen nor the formation of a cooking or baking flavour which is produced by the cooking of the juice required for the concentration or bottle-stabilisation of the juice).

The complete expulsion of the absorbed oxygen and the elimination of any possibility of oxydation hinders the development of the yeast cells and the few branch yeast cells which may be produced, are no longer to be feared. The aforesaid temperature below the freezing-point is prevailing so long as required for preventing fermentation during bottling and an eventual stabilisation (of turbid juices).

When juices are to be furnished absolutely clear, requiring clarifying, filtration and even ultra-filtration, it is easy to prevent them from warming above the very low temperature to which they are brought.

The method based on the aforesaid statements and in accordance with the present invention consists of atomizing colloidally and of homogenizing the juice to be treated, then dispersing it under a high vacuum, then dropping the temperature of the juice below the freezing point by boiling and simultaneous evaporation until complete expulsion of the gases, i. e. complete extraction of the oxygen, the produced vapours as well as the gases absorbed by the juice being continually sucked off by vacuum, and immediately filling the produced liquid in receptacles for storage or delivery.

The colloidal atomizing and homogenizing of the juice is preferably effected in the vacuum also, and all aforesaid operations are advantageously carried out in the same evacuated receptacle. After the homogenizing and dispersion of the juice, the extraction of the oxygen physically dissolved in the juice may be effectuated instantly whilst the temperature of the juice is simultaneously and in a fraction of a second lowered below the freezing point, viz. down to 28,4° Fahrenheit, owing to boiling and the resulting evaporation under an absolute pressure of appr. $\frac{5}{32}$'' of mercury which head corresponds to the pressure of water-steam at a temperature of 28,4° Fahrenheit. This intense cooling causes the precipitation of certain components whereby the clarifying of the juice is effectuated.

It is not absolutely necessary that the colloidal trituration and the homogenizing are carried out in the same apparatus and under approximately absolute vacuum, but this is preferred in order to prevent that on the one hand the juice which is exposed during a relatively long leriod of time to the air oxidises, and on the other hand a loss of energy occurs by heating the juice in contact with air. The simultaneousness of the colloidal trituration, of the extraction of the oxygen and of the cooling down to the freezing point, f. i. to 28,4° Fahrenheit, and this during the same fraction of a second permit to realize an obvious advantage.

The colloidal trituration and the intense ho-

mogenizing make all fruit stew and cell particles disappear and eliminate the inconveniences which may be associated to the presence of such particles, f. i. the action of yeast cells which may be hidden in such a juice stew, the danger of caramelisation resulting from a subsequent heating and also the possibility of small quantities of juice being retained, juice of which might so escape to the action of the disoxidising processus.

A preferred manner of carrying out the method according to the invention is described hereinafter:

The introduced juice is first subjected to an intense colloidal trituration and homogenizing which is carried out so to say in an absolute vacuum of 5/32'' of mercury corresponding to a boiling temperature of the juice of 28,4° Fahrenheit. After that, the juice is dispersed past through a strainer under the action of its own weight. Then is effectuated the complete extraxtion of the oxygen absorbed in the juice by extracting the water-steam produced by boiling in absolute vacuum, the produced steam being continually sucked off. The cooling of the juice close to the freezing point is obtained by evaporating a portion of the water contained in the juice boiling it under vacuum. Clarification of the juice is started by the beginning of the precipitation of certain components caused by the cooling in the vacuum, and consequently in absence of air.

All these operations can be carried out in the same receptacle of the apparatus and this in a rapid succession of fractions of a second.

Juices which are to be furnished in a clear state, are heated up to from 122–140° Fahrenheit in order to obtain a preliminary clarification. Then the juices are filtred, bottled under vacuum and sterilized.

The apparatus according to the invention for carrying out the aforesaid method comprises in combination means, i. e. a mill for the colloidal atomization and homogenizing of the juice by means of an intensive trituration of the fruit stew and cell particles arranged in a hermetically sealed receptacle which also contains a dispersing device with the necessary openings and connecting-sockets and to which is connected a device for generating a high, so to say absolute vacuum which enables to boil the juice at a very low temperature owing to continually sucking off the produced vapours from the said receptacle.

A preferred embodiment of the apparatus according to the invention is illustrated in the annexed drawing, of which fig. 1 shows a sectional elevation, whilst fig. 2 shows a modification of a fragment of the apparatus in elevation and partial section.

In the shown apparatus, the juice coming from the not shown press of a known kind and design and freed from kernels passes through the pipe 1 into the collector 2. This collector vessel 2 has a jacket 3 and a central cavity 4 filled with a cooling liquid which is introduced through the socket 5 and drained through the socket 6. For draining the cooling liquid, the central cavity 4 is connected to the side wall of the jacket by a pipe 7.

In the collector 2 is immersed the end of a succion pipe 9 which connects the same to the inlet-socket 10 of the receptacle 11. In the pipe-line 9 is inserted a valve 13 for the admission or cutting-off of the juice, and adjacent to the said valve is provided a diaphragm 12 with a central aperture for the regulation to a maximum of the quantity of liquid admitted.

The inlet-socket 10 is arranged on the side wall of the receptacle 11 above a funnel 14 closely connected to the cylindrical wall of the receptacle and which conveys the introduced juice to the colloidal mill which is to effectuate a colloidal trituration and homogenizing of the juice to be treated. Said mill is provided with a rotor 16 directly fitted on the shaft 18 of an electrical motor 17 located in the upper part of the receptacle 11, so that it is rotating at high speed.

Current is fed to the motor 17 by means of a cable 19 introduced through the wall of the receptacle 11 by means of an airtight stuffing-box 20.

The rotor of said mill may be ribbed or otherwise corrugated on its circonferentiel surface and is preferably shaped to a tronconde form in order to permit adjustment of the air gap between the rotor 18 and the stationary milling crown 21. The rotor 16, therefore, can be approached to the stationary milling crown 21 corrugated in a simlar manner, so as to reduce the air gap to an extremely small extent thereby permitting trituration to a maximum of fineness and a very extreme homogenization.

For the dispersion of the juice draining from the colloidal mill, in the receptacle 11 is provided a strainer 22 of stainless steel or enamelled iron sheet connected at its border to the wall of the receptacle 11 and fitted with an upright pipe 23. Number and size of the strainer openings are to be dimensioned in such a way as to allow the juice to collect above said strainer to a height of some inch. The passage through those perforations must be in correspondence to the hourly output of the apparatus as controlled by the aperture of the diaphragm 12 and which is in accordance with the generated vacuum.

To the cylindrical receptacle 11 is joined to its lower border a troncone-shaped tube 25 slightly diverging downwards and immersed in a larger receptacle 24 in the cover of which it is inserted eccentrically, so that the apparatus is fitted with two chambers separated by the strainer 22. In order to obtain an equilibration of pressure, the two chambers are interconnected to one another by the tube 23 emerging from the level of liquid above the strainer 22. The parts 11, 25 and 24 of the apparatus are made of iron sheet enamelled on the inside in order to prevent the development of a metallic flavour.

Diametrically opposed to the tube 25 is located at the highest point of the side wall of the receptacle 24 a large outlet-opening 27 through which the gases and vapours generated during the boiling of the juice in the vacuum may escape. To this opening is connected the vacuum generating device the design of which is as follows:

For generating the vacuum, a steam ejector 28 is provided connected to the steam pipeline 50, said ejector drawing off the gases and vapours of the receptacle 24 and conveying them to a condenser 29. The latter has a vessel in which is inserted a strainer 30 for the distribution of the introduced water.

To the condenser 29 is connected a further ejector 32 for extracting the gases contained in the juice and the condense-water. The ejector 32 conveys the drained gases into a second condenser 33 of a similar but smaller design as the aforesaid condenser.

A third ejector 36 connected to the outlet of

the condenser 33 draws the gases out of the said condensor and exhausts them to the air.

To the two aforesaid condensors 29 and 33 are connected water-pipes 37 and 38 conveying the condense-water into a water reservoir 39. Said two water-pipes 37 and 38 must have a length corresponding to the minimum of barometrical pressure.

The feeding of water to the two condensors 29 and 33 is effectuated by means of a pipe 49 branched off the water-reservoir 48 and from which the water is drawn into the condensors by vacuum.

On the lower end of the conical bottom of the receptacle 24 is arranged an outlet-socket 41, through which the juice drains off through a cock 43 and the pipe 42 and enters the juice receptacle 44. This pipe must be somewhat shorter than required by the barometrical height.

The juice reservoir 44 comprises a separating wall 45 and at the bottom a connecting socket for the juice drain pipe 46 to carry on the treated juice. This may be conveyed either right into a bottling machine or into two pasteurise-apparatus 47 and 28 known per se which may be taken in use alternatingly. Said pasteurise-apparatus are connected to the vacuum and may be used as storing receptacles when pasteurising is not desired.

Should the local conditions not allow the required height of the described apparatus, pumps may be employed for drawing off of juice and water.

Instead of the described strainer 22, another dispersion device could be provided, f. i. tangential- or vertical spraying nozzles of a known design which disperse the liquid in a spray or rain by means of its velocity.

The manner of operation of the aforedescribed apparatus for carrying out the method according to the invention is as described hereinafter:

When starting the apparatus, care should be taken that the steam pressure is regulated by means of a steam regulator and a water-separator inserted in order to keep the introduced vapour dry. Further must the water-pipings 37 and 38 be filled with water and the pipes 9 and 42 with juice. It is further important that the introduced juices are fully free of impurities.

Now, the steam valves of the ejectors 36, 32 and 28 are opened slowly and one after the other. The vacuum generated by the two condensers 29 and 33 reduces the pressure to ab.5/32'' of mercury.

Then the valve 13 of the juice-inlet is opened and the driving-motor 17 of the colloidal-mill started. The juice is triturated and homogenized in said mill, passes the strainer 22 and drops under its own weight as a rain into the tube 25 where each drop is brought to boiling in the vacuum prevailing in the receptacles 11 and 24, thereby producing on the one hand a cooling of the juice and on the other hand the expulsion of the gases and vapours contained in the juice which are immediately and continually drawn off through the opening 27.

The cooled juice freed from the gases leaves the receptacle 24 past the outlet 41 and is conveyed through the pipe 42 into the juice reservoir 44 from which it may be drawn off for further use whilst the gases and vapours are sucked off at 27 pass the two condensors 29 and 33.

It is advisable to pour on the surface of the juice in the open reservoir 44 a thin layer of oil in order to prevent all contact of the juice with the air. When the juice is circulating in this reservoir, the essence-oils which have been freed by the effect of the trituration and homogenizing in the colloidal mill, may mix themselves with said layer of oil.

The collector 2 serves as a storing receptacle for the feeded juice and it is not to be feared that the temperature of the treated juice is influenced by variations of the level of liquid in said collector.

Continuous operation when carrying out the aforedescribed method is not absolutely necessary and provisions could be taken for an intermittent operation of the boiling and evaporating process. An arrangement of this kind is illustrated in Fig. 2 of the drawing. In this arrangement, the lower end of the receptacle 11' enclosing the colloidal mill 16/21 with its driving motor 17 as aforedescribed is connected by means of a two-way cock 52 to a bifurcated pipe 51 which conveys the triturated and homogenized juice into the two dispersing apparatus which may be taken alternatingly in use. Each dispersing apparatus comprises a receptacle 25*a* or 25*b* respectively with a tronconical tube as aforedescribed and enclosing a strainer 22*a* with a tube 23 for the equilibration of pressure in the two chambers. The tronconical tube immerges into the receptacle 24*a* or 24*b* respectively as aforedescribed forming thus a device with two chambers of vacuum interconnected by the tube 23*a*. From the outlet 41*a* or 41*b* respectively at the bottom of the receptacle 24*a* or 24*b* respectively, the collected juice is conveyed off through the valve 43*a* or 43*b* respectively and the pipe 42*a* or 42*b* respectively, whilst the extracted vapours and gases of the juice may be sucked off at the outlet opening 27*a* or 27*b* respectively and conveyed to the condensing apparatus connected to the outlet openings 27*a* and 27*b* respectively as aforedescribed. The two devices 25*a*/24*a* and 25*b*/24*b* may be taken alternatingly in use by means of the two-way cock 52 producing thus an intermittent dispersion and extraction process. For the remaining part, the operation as well as the apparatus are completely corresponding to the aforedescribed operation and apparatus.

When a preliminary cooling of the juices is intended, the apparatus producing the vacuum and the refrigeration may be used for cooling the cooling liquid.

It is to be understood that the present invention is not to be limited to the exact details of the method and construction shown and described, but changes could be made within the spirit and scope of the invention.

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