IMPROVED CONTROL AND SLOWING DOWN SYSTEM FOR THE RIPENING PROCESS OF BANANA FRUIT

A process is described for improved control and slowing down the ripening of banana fruit. The process comprises the harvest of the banana tree with the roots and watering of the tree trunk and banana bunch in regular intervals during transport and/or storage.
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IMPROVED CONTROL AND SLOWING DOWN SYSTEM FOR THE RIPENING PROCESS OF BANANA FRUIT

The present invention relates to a process for improved control of the ripening process and for slowing down the ripening process of banana fruit.

One main problem in connection with the trade of bananas is the necessity to transport them over long distances and for long time periods. This often leads to damage to the skins or flesh of the bananas to be marketed. The damage can be in the form of change in color of the banana skin or the degradation of the banana taste, so that it brings about losses both to the producers and consumers of bananas. One reason for the damage is that bananas cannot be stored for a long period of time. Rather, the ripening process of the bananas continues during transportation and the ripe bananas are much more susceptible to damage. In order to avoid too much damage to the fruit during transportation, bananas are normally harvested in an unripe state when they have been grown for about 70% of the time normally required to harvest ripe bananas. In this state the bananas are still green. Although less damage occurs during long transportation periods using this method, the disadvantage is that the fruits are not soft after the skin has turned yellow and the fruit do not taste as good as bananas ripened under natural conditions.

Thus, the problem underlying the present invention is to provide a process for the improved control of the banana fruit ripening and for slowing down the ripening, thus avoiding the disadvantages of the known methods.

This problem is solved by the embodiments characterized in the claims.

Thus, the present invention relates to a process for the improved control of banana fruit ripening and/or slowing down the process of fruit ripening comprising the steps of:
(a) harvesting the banana infructescence (bunch of fruits) together with the tree trunk; and
(b) watering of the trunk and the infructescence during transportation and/or storage; and
(c) heating the infructescence and trunk during transportation and/or storage.

It has been found that by the above process, the ripening of the banana fruit can be efficiently controlled. Furthermore, the resulting ripe fruits are more solid and the skin has a finer color compared to bananas that ripened under natural conditions.

In a preferred embodiment, the tree trunk harvested according to step (a) of the process according to the invention is harvested together with roots and preferably still comprises intact roots. The function of the roots is the uptake of nutrients necessary for the tree's survival.

One possible and preferred way of obtaining banana tree trunks with roots is to cultivate the banana tree in a plastic bag filled with earth which is not completely closed at its lower side. The banana tree having nearly ripe fruits can then easily be removed from the plastic bag with roots intact, for example, by first removing the soil around the roots from the plastic bag and then lifting it with a special device.

The plastic bag used for cultivating the bananas normally has a surface of about 4 square meters, is about 80 cm high and is filled with earth. On the lower side the plastic bag should have holes so that the roots may penetrate into the soil beneath the plastic bag (see Figure 1). Preferably, the plastic bag is not inserted into the ground but is placed on the ground in order to facilitate the easy cutting of the roots penetrating through the lower side of the plastic into the soil beneath it.

As can be seen from Figure 4, the tree trunk with roots can be obtained easily by removing the earth from the plastic bag around the base of the banana tree and cutting the roots that penetrate through the lower side of the plastic bag into the
soil. A further advantage of the use of a plastic bag for cultivating the banana plant is that less fertilizer is required. The fertilizer can be added directly to the soil in the plastic bag.

In a particularly preferred embodiment the process according to the invention comprises a step in which the formation of radial roots of the harvested banana trunk is promoted. For this purpose the base of the banana trunk may be placed in a mixture of water, coconut milk and a suitable fertilizer. Preferably the trunk is placed on a kind of wooden shelf (see Figure 4) and in a plastic bag containing the above-described solution. The plastic bag is preferably permeable for oxygen. After 5 to 8 days radial roots develop on the roots of the banana tree trunk.

In another preferred embodiment the leaves of the banana tree trunk are removed before the infructescence is harvested together with the tree trunk according to step (a) of the process according to the invention.

The removal of the leaves is preferably done just before the harvest of the bananas. The leaves should be removed from the upper part of the tree downwards. Removing the leaves makes it easier to transport the banana trunk in the following steps and saves space.

The banana tree - the branches of which had been cut off and the roots of which had been disconnected from the soil - can then be lifted from the plastic bag by a suitable device. This should be done carefully so as to avoid any damage, in particular to avoid tearing off of parts of the infructescence. Special care should be taken that no damage occurs where the bunch is very delicate at the curve forming a reverse U shape. Care should be taken at this stage that the xylem of the infructescence and the tree is not damaged. The xylem of the tree trunk supplies the infructescence with liquid and is thus extremely important for preventing the banana fruit from drying and premature ripening. Preferably, the device used for lifting and transporting the banana tree comprises a container
having a special mould into which the tree trunk fits. Such a container may be, for example, made of fiber glass.

Normally, the weight of the fruit bunch and the tree trunk is about 120 kg. Thus, the device used for lifting and transportation should be designed for the handling of such weights.

After lifting the infructescence with the tree trunk from the plastic bag, it is preferably placed in a pool in order to be further cleaned of soil. Preferably the washing of the base of the tree trunk and the roots, not including the infructescence (bananas), is carried out by using clean water (drinking water). For this purpose, the base of the tree is submerged for about 30 minutes in order to soften the remaining soil sticking to the base and the roots of the trees. The soil is then removed by using, for example, a brush (a wire brush may be used). Subsequently, the tree trunk and the roots may be further cleaned by spraying it with water under high pressure in order to remove all soil from the trunk and the roots. The bananas may be cleaned by spraying them repeatedly for about 20 minutes with soap water. The soap used can be any commercially available laundry soap. The tree (not including the bananas) may furthermore be treated in order to remove insects. This may be achieved, for example, by spraying it with warm water.

Furthermore, the tree (not including the infructescence) may be submerged in a solution of red chili, which has first been crushed and mixed with a solution of crushed garlic. In order to efficiently remove any insects, the tree should be submerged in such a solution for at least about 30 minutes. Subsequently, the tree and the bananas are washed again for about 20 minutes with clean water.

In order to kill any remaining insects, the tree (including the bananas) can be placed into a pool of fiber glass filled with water and a single phase (N) of high current is applied to the water.
In a preferred embodiment, the banana tree is peeled from the base to the part just before the infructescence after harvest according to step (a) of the process according to the invention. Furthermore, any parts of the roots which are damaged are preferably removed. Most preferably, approximately 6 layers around the trunk, which corresponds to a depth of about 2 cm of the bark, are removed. Accordingly, parts of the roots are removed by preferably cutting up to a depth of around 2 cm from the damaged part. The bark of the trunk is preferably removed since it has generally the characteristic of dry wood in which insects are nesting. After peeling of the bark and the damaged part of the roots, the clean tree trunk may be further subjected to a radiation with gamma rays towards the base of the tree.

In a further preferred embodiment, the base of the tree is covered with humus, preferably of seaweed material, and wrapped in wet cotton. The humus is used to cover the roots of the banana tree in order to provide them with moisture. It is spread around the roots and optionally sprayed with water. The advantage is that it can also be easily penetrated by air and prevents clogging of the roots. The wet cotton preferably has a water content of between 90 and 95%, more preferably between 91 and 93% and most preferably of about 91.49%. Preferably the wet cotton has an alkaline pH.

In a more preferred embodiment, the trunk wrapped in wet cotton is furthermore wrapped with a thin layer of foam rubber by applying a drying method of up to 105°C and using a pH meter method of 5% solution with a pH value of 6.55. For this purpose, preferably a think layer of rubber foam of about 100 cm x 100 cm with a thickness of 1 cm is used. The cotton is pressed with a machine to make it soft and light. After this treatment the cotton should have a thickness of about 2 cm and a surface of about 100 cm x 100 cm. It is then placed on the rubber foam.

The roots of the trunks which are long and healthy are then coiled in the same direction so as to avoid damaging them.
Then a piece of hard foam of about 15 cm x 5 cm x 15 cm is placed on the cotton as a supporting pillow to make it easier to keep the humus stay near the lower part.

The tree trunk, which is prepared as described above, is then placed on top of the rubber foam. The humus is spread in a layer of about 15 cm around it. Then the foam is wrapped around the trunk and tied to it.

In a preferred embodiment of the present invention, the watering according to step (b) of the process is performed regularly approximately every 12 hours and lasts for about one hour. Preferably, watering takes place during the day time between 11 a.m. and 12 o’clock.

The spraying with water in regular intervals may be controlled, for example, by an automatic device. An example of such a device is shown in Figure 8a. It comprises: (1) a modified clock; (2) a sensor; (3) a relay; (4) a D.C. battery of 24 volts; (5) a water pump powered by the battery and a tub for drinking water and ice-cubes. Every time the needle of the clock passes the photo electric sensor, the light detects the crossing needle and sends a signal to the relay unit to switch between the on/off status.

Alternatively, an automatic timer may also be used for switching on and off the pump for spraying the water (see Figure 8b).

In a further preferred embodiment, the watering is performed with water having a temperature between 20 and 28 °C. The spraying with water carried out during the daytime is expected to be capable of stimulating a kind of filament liquid to slip under the layer of green fruit skin. The fruit skin which is originally wrinkled, will then smoothen due to the regular spraying. The watering is furthermore done in order to keep the roots of the tree trunk wet, to meet the needs of the fruit stem for water, and to cool down the banana skin.
The heating of the bananas according to step (c) of the process is normally carried out in regular intervals, preferably every 24 hours for about 8 hours. One possibility to achieve a suitable heating of the bananas is the use of halogen lamps, preferably with a capacity of 200 watts.

It appears as if the banana skin as well as the stem are built of structures having the shape of a reverse U and that the change of temperature is required to open the pores to allow a kind of filament fluid contained in the skin and stem to evaporate. By use of heat treatment, it is possible to increase the uptake of water by the banana tree during transport and/or storage. The circulation of fluid in the fruit is stimulated and thus the fruit skin tightens.

The heating temperature of the bananas is preferably in a temperature range of 30 to 36°C. The cooling down of the bananas after heating can be achieved simply by stopping the heating or alternatively by spraying the bananas with water. It is preferred that the heating of the bananas and the spraying with water is carried out simultaneously. Preferably the heating takes place between 9. a.m. and 4 p.m.

In a particularly preferred embodiment of the process according to the invention, the tree trunk bearing the bananas is kept during transportation and/or storage in a special transport and/or storage device, i.e. in a container which is specially designed for this purpose. This container preferably has a solid base but has at least one side wall and/or a top which allows the passing through of air. Most preferably, the side walls and the top are made out of wire mesh.

The dimension of such a container is preferably about 20 to 40 feet x 2.9m x 2.3m. In a particularly preferred embodiment, the container is equipped with means for spraying the bananas and the tree trunk with water, for heating the bananas and the tree trunk and/or with means for ventilation, for example, a fan (see Figure 10).
In another preferred embodiment the container contains in its lower part a wire mesh in a distance of at least 4 cm, preferably of at least 10 cm, more preferably of at least 20 cm and even more preferably of at least 40 cm above the base. The size of the mesh is so that a banana trunk can fit between it. Moreover, the container contains in this preferred embodiment an elastic rubber sheet placed over the above described wire mesh. This rubber sheet contains holes of about ±20 cm diameter in which the trunks of the harvested banana trees can be placed.

Furthermore, in this embodiment the basis of the container is filled with a gel prepared from a powder of seaweed extracts. This powder is preferably that named "Cineau" which can be obtained in Korea. The gel can be prepared by dissolving the powder in water (e.g. 20 grams in 6 liters), boiling it for a brief time and cooling it down to 90°C. It is then poured into the container to a height of up to ±20 cm. Upon cooling down further, the liquid will form a gel. Finally, the container according to this preferred embodiment also contains means to refrigerate the described gel so that it does not loose too much water and is not contaminated by bacteria, algae or fungi. Preferably, these means ensure that the gel has a temperature of about 10°C.

The container of this preferred embodiment allows now to store and/or transport the harvested banana tree trunks in the following way:

The banana tree trunks are placed in the container in an upright position (see Figures 11 and 12) and their trunks are placed in the holes of the rubber sheet and the wire mesh. The base of the tree trunk with the roots is placed in the above described gel. The gel produced from the seaweed powder promotes the generation of new fine roots (radial roots). This ensures that the tree trunks are sufficiently supplied with water. The means for refrigerating the gel as well as the rubber sheet covering the wire mesh and the gel ensure that the gel does not loose too much humidity. In this context it should be mentioned that the holes in the elastic rubber sheet should have a size so that the sheet fits tightly to the tree trunks placed in it.
The liquid which will form the gel is preferably poured into the container after all the tree trunks have been placed in the container in an upright position as described above.

In a particularly preferred embodiment the above described container furthermore comprises means to fasten the infructescences of the banana tree trunks so as to relieve burden of the xylem in the U-spaced curve in the stem. Such means are preferably belts made of PVC which can be fastened at the top of the side walls of the container. The present invention also relates to a container as described above.

Using the process according to the present invention, it is possible to shorten the time period from the planting to harvest to about 390 days. In contrast thereto, this period normally lasts about 460 days. The process according to the present invention allows efficient control of the ripening of banana fruit and also leads to fruit with a more solid flesh and with a banana skin with better appearance. Furthermore, this process allows for transportation of the harvested bananas over long distances and for long periods of time without severe damage and without using any chemical treatments. Moreover, the process of the present invention allows to transport bananas up to 42 days without a loss of freshness or quality of the bananas.

Figure 1 shows schematically a banana tree cultivated in a large plastic bag, the lower part of which is not completely closed in order to allow roots to grow into the soil beneath the bag.

Figure 2 shows a banana tree with an infructescence (bunch of bananas) whose leaves have been fully cut off.

Figure 3 shows the removal of the soil around the base of the banana tree in the plastic bag.
Figure 4 shows schematically a lifting device for removing the banana tree from the plastic bag.

Figure 5 shows the washing carried out in the pool.

Figure 6 shows a banana tree whose outer skin has been peeled off, and some of the intact roots that grow at the base of the banana tree.

Figure 7 shows the wrapping of the banana tree with foam rubber.

Figure 8a and b show schematically devices for automatic spraying of the bananas during transport or storage.

Figure 8a: 1. The clock that has been adjusted
2. Optic sensor
3. Switches
4. Power Supply Battery
5. Sprayer
6. Banana trees ready for watering

Figure 8b: 1. Solid state timer
2. Relays
3. Power supply battery
4. Sprayer
5. Banana trees ready for watering

Figure 9 shows schematically the arrangement for promoting growth of radial roots of the harvested banana trunk:
A : mixture of water, coconut milk and fertilizer
B : plastic bag permeable for oxygen
C : wooden shelf
D : radial roots

Figure 10 shows schematically an example of a device for transporting and/or storing bananas:
1. Wire with holes
2. Spraying device
3. Water container
4. Halogen lamp
5. Fan

Figure 11 shows schematically a further example of a device for transporting and/or storing bananas according to a preferred embodiment of the invention.
1. Wire with holes
2. Spraying device
3. Water container
4. Halogen lamp
5. Fan
6. Safety belt
7. Rubber sheet
8. Iron rack with legs (wire mesh)
9. Liquit cincau – (Pure seaweed extracts)

Figure 12 shows further details of the container shown in Figure 11.
1. A soft belt to support the stems of the banana tree trunks
2. Elastic rubber sheet with holes in it
3. Wire mesh with legs
4. Gel prepared from seaweed powder
5. Means for refrigerating the gel
6. Overview over arrangement of the devices in the container
CLAIMS

1. A process for the improved control of banana fruit ripening and/or slowing down the process of fruit ripening comprising the steps of:
   (a) harvesting the banana infructescence (bunch of fruits) together with the tree trunk;
   (b) watering of the trunk and the infructescence during transportation and/or storage; and
   (c) heating the infructescence and trunk during transportation and/or storage.

2. The process of claim 1, wherein step (a) is further characterized in that the trunk comprises roots.

3. The process of claim 1 or 2 further comprising a step for promoting growth of radial roots comprising placing the base of the tree trunk in a solution of water, coconut milk and a fertilizer.

4. The process of any one of claims 1 to 3 further comprising the step of removing the leaves from the plant before carrying out step (a) of claim 1.

5. The process of any one of claims 1 to 4 further comprising the step of cleaning the tree trunk and infructescence of soil and insects.

6. The process of claim 5 wherein the removing of insects is achieved by
   (a) washing and/or spraying with water;
   (b) submerging the tree trunk in a solution of crushed red chili mixed with a solution of crushed garlic;
(c) placing the tree trunk in a pool filled with water and applying a single phase of high current;
(d) subjecting the tree trunk to gamma-radiation;
wherein any of these measures is applied alone or in combination with at least one of the other measures.

7. The process of any one of claims 1 to 6, further comprising the step of peeling the trunk of the plant and/or cutting damaged roots after carrying out step (a) of claim 1.

8. The process of claim 7, wherein the peeling of the trunk is carried out until about 2 cm in depth of the bark is removed which corresponds to about 6 layers of the bark.

9. The process of any one of claims 1 to 8 further comprising the step of covering the trunk with humus, wrapping it into wet cotton after having carried out step (a) and furthermore wrapping it with a thin layer of foam rubber.

10. The process of any one of claims 1 to 9, wherein step (b) is further characterized in that the watering is performed regularly every 12 hours for a time period of about 1 hour.

11. The process of any one of claims 1 to 10, wherein the watering is performed with water having a temperature of about 20°C to about 28°C.

12. The process of claim 11, wherein the heating of the infructescence is performed regularly every 24 hours for a time period of 8 hours.

13. The process of claim 12, wherein the heating temperature is in the range of 30°C to 36°C.
14. The process of any one of claims 1 to 13, wherein the banana tree trunk is kept during transportation and/or storage in a device having a solid base and at least one side wall and/or a top allowing the passing through of air.

15. The process of claim 14, wherein the side wall(s) and/or top of the device are made out of wire mesh.

16. A device as defined in claim 14 or 15 further comprising means for watering the banana tree trunk, means for heating the infructescence and/or means for ventilation.

17. The device of claim 16 further comprising a wire mesh at the base of the container, an elastic rubber sheet with holes in it covering the wire mesh, a gel prepared from seaweed powder at the bottom of the container and means for refrigerating the gel.

18. The device of claim 17 further comprising means to fasten the stems of the banana tree trunks which are placed in upright position in the container.
Fig. 5

Fig. 6

Fig. 7
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 6 A23B/148

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)

IPC 6 A23B

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 practical, search terms used).

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>WO 95 00030 A (CHIQUITA BRANDS) 5 January 1995 see page 9, line 5 - page 11, line 14</td>
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<td>FR 2 690 043 A (LATINE EUROPE) 22 October 1993 see page 8, line 1 - page 9, line 24; figure 1</td>
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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

20 November 1998

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