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GB 2163637 A
WO 2001/071258 A2
WO 1993/002563 A1
ES 002149688 A
JP 090023740 A

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UK CL (Edition V) **A2D**
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Other: **Online:EPODOC,WPI,JAPIO**

(54) Abstract Title: **Controlling sprout growth in a root vegetable**

(57) An apparatus for controlling the ethylene concentration in a root vegetable storage facility comprises an ethylene concentration sensor and an ethylene concentration controller, the ethylene concentration controller being configured, in use, to be responsive to a signal from the ethylene concentration sensor, which signal corresponds to the ethylene concentration in the facility at any given time, to initiate the release of ethylene from an ethylene source only when the signal indicates that the ethylene concentration has fallen below a pre-selected minimum, thereby to maintain the ethylene concentration above the pre-selected minimum desirable ethylene concentration. Preferably, the release of ethylene is stopped when the ethylene concentration exceeds a given value.

Also, a method for controlling sprout growth in a root vegetable stored above ground comprises the steps of:

a. storing a root vegetable under an atmosphere of air at a temperature of less than 9°C for up to 4 months;
b. storing the root vegetable under an atmosphere comprising ethylene at a concentration greater than 4 ppm at a temperature of less than 9°C for up to 12 months; and
c. removing the root vegetable from storage under the said ethylene atmosphere for subsequent packaging.

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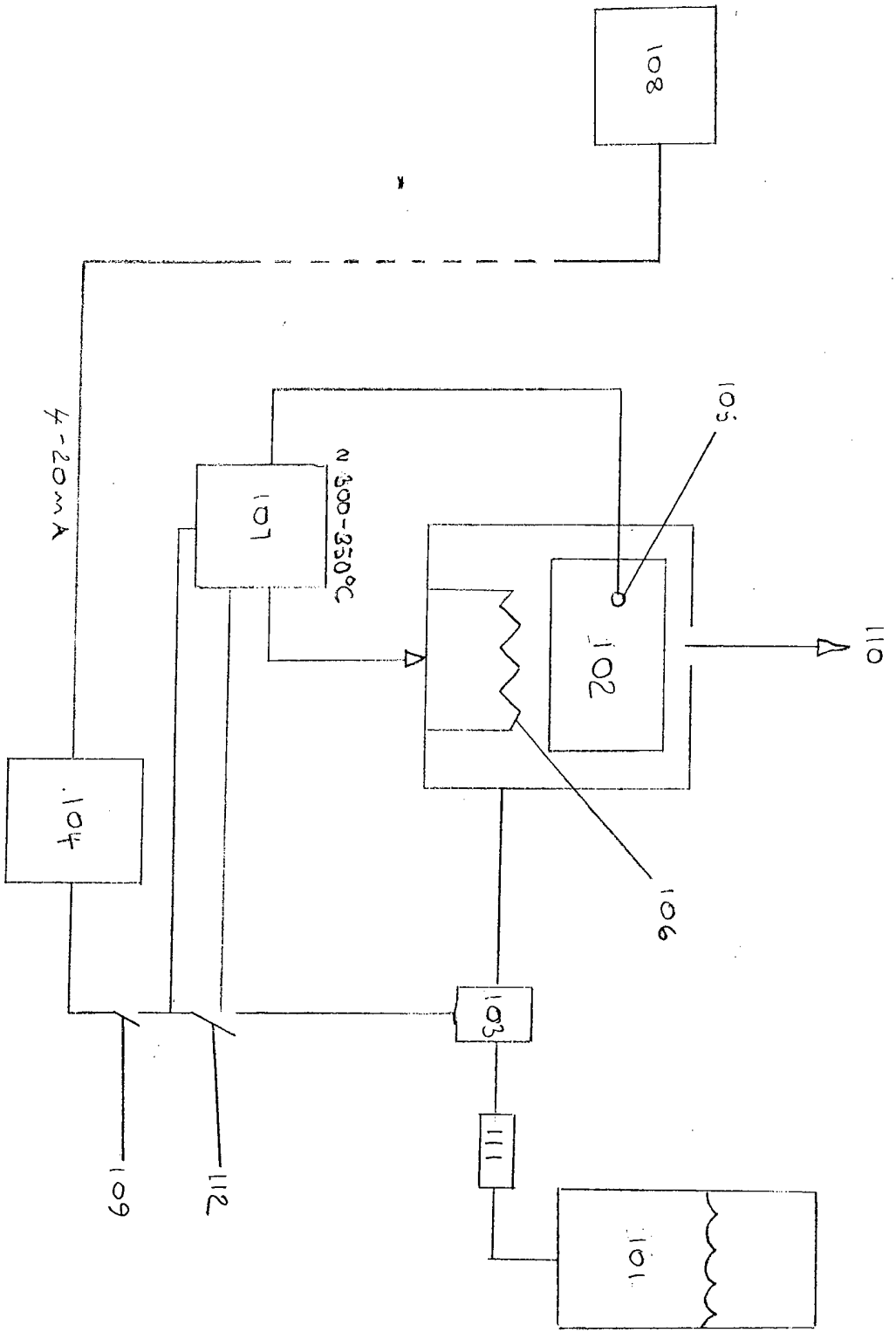

FIGURE 1

APPARATUS AND METHOD FOR CONTROLLING SPROUT GROWTH IN A ROOT VEGETABLE

The present invention relates to an apparatus for controlling the ethylene concentration in a store for above ground storage of root vegetables. The invention also relates to a method for controlling sprout growth in a root vegetable stored above ground, such as a potato tuber and an onion bulb, after dormancy break by prolonging the natural storage period of the root vegetable by inhibiting sprouting.

A number of methods for controlling sprout growth in a root vegetable stored above ground exist. In one method, maleic hydrazide is applied to potato plant leaves in the field 3-7 weeks before the expected date of topkill or first frosts. In another method, chlorpropham (CIPC) is applied to stored potato tubers in the form of an aerosol after the tubers have suberized. CIPC is reapplied as required throughout the storage period. A further method is to burn out any sprouts by the application of hydrogen peroxide. It is also known to apply dimethylnaphthalate (DMN) to potato tubers in storage by aerosol application. The application is repeated as required throughout the storage period.

There is increasing consumer pressure for the food processing industry to reduce pesticide levels. Therefore it will be appreciated that one problem with the aforementioned methods is that they all involve the use of chemicals which may leave undesirable residues in the product. A further problem is that the application of such chemicals can be time consuming.

Proposed Regulatory Decision Document PRDD2001-04 discloses a method comprising applying ethylene at a concentration of up to 4 ppm to cultivar *Russet Burbank* potato tubers stored in a commercial potato store at a temperature of 9°C. The storage conditions are selected to minimise the development of sugars that are detrimental to the fry colour (lead to dark brown chips).

Onion bulbs are stored at 0.5°C from September to January. Storage from September to April is achieved under an atmosphere of low oxygen and high carbon dioxide concentrations. One disadvantage of this method is that the equipment required to maintain such an atmosphere is expensive. Furthermore, personnel cannot enter these stores without breathing apparatus. For storage from September to June, maleic hydrazide is applied to the onion plant leaves in a manner similar to that described for potato tubers.

Summary of the Invention

The present invention aims to address the problems and disadvantages of existing apparatus for controlling the ethylene concentration in a store for above ground storage of root vegetables and the problems and disadvantages of existing methods previously discussed for controlling sprout growth in root vegetables stored above ground.

In a first aspect, the invention provides an apparatus for controlling the ethylene concentration in a root vegetable storage facility comprising an ethylene concentration sensor and an ethylene concentration controller, the ethylene concentration controller being configured, in use, to be responsive to a signal from the ethylene concentration sensor, which signal corresponds to the ethylene concentration in the facility at any given time, to initiate the release of ethylene from an ethylene source only when the signal indicates that the ethylene concentration has fallen below a pre-selected minimum desirable ethylene concentration in the facility, thereby to maintain the ethylene concentration above the pre-selected minimum desirable ethylene concentration. Desirably the pre-selected minimum ethylene concentration is 5 ppm and preferably 8 ppm.

This apparatus advantageously provides a feed back mechanism for maintaining the ethylene concentration within the root vegetable storage facility above a minimum effective concentration.

Preferably the ethylene concentration controller can be additionally configured, in use, to be responsive to the signal from the ethylene

concentration sensor to arrest the release of ethylene from an ethylene source when the signal corresponds to an ethylene concentration greater than or equal to a pre-selected maximum ethylene concentration in the facility, thereby to maintain the ethylene concentration within a range defined by the pre-selected minimum and maximum desirable ethylene concentrations.

Desirably the pre-selected maximum ethylene concentration is 20 ppm and preferably 13 ppm. In pre-selecting a maximum ethylene concentration, the release of ethylene can be optimised to prolong the natural storage period of a root vegetable without needlessly wasting ethylene.

In a particular embodiment, the ethylene concentration sensor is an electrochemical sensor, although other forms of ethylene concentration sensor may be used. The sensor is robust, accurate and sensitive.

The apparatus can additionally comprise an ethylene source, for example a compressed gas cylinder containing ethylene gas or preferably a catalytic ethylene generator. The latter comprises a catalyst which, in use, converts a feedstock of ethanol to ethylene. Storage and refilling of this feedstock is less tiresome and considered safer than compressed ethylene gas in a cylinder. Normal safe practice for banana ripening room ethylene injection from a cylinder is to use a cylinder containing ethylene mixed with air or nitrogen so that the mixture is below the explosive limit. This is then safe but more expensive.

The catalytic ethylene generator may comprise a catalyst heater, a catalyst temperature controller and a catalyst temperature sensor, the catalyst temperature controller operating the catalyst heater and being configured to be responsive to a signal from the catalyst temperature sensor, which signal corresponds to the catalyst temperature at any given time, to switch on the catalyst heater when the signal indicates that the catalyst temperature has fallen below a pre-selected desirable catalyst temperature thereby to maintain the catalyst temperature above the pre-

selected desirable catalyst temperature. The ethylene concentration controller may include the catalyst temperature controller.

Optionally the catalytic ethylene generator further comprises a valve for controlling the release of generator feedstock to the catalyst, the valve being operated by the ethylene concentration controller, the ethylene concentration controller being configured to open the valve to release generator feedstock to the catalyst only after the catalyst temperature sensor indicates to the catalyst temperature controller that the catalyst temperature is at or above a pre-selected minimum catalyst temperature.

Alternatively, the catalytic ethylene generator can further comprise a valve for controlling the release of generator feedstock to the catalyst, the valve being operated by the catalyst temperature controller, the catalyst temperature controller being configured, in use, to be responsive to a signal from the catalyst temperature sensor, which signal corresponds to the catalyst temperature at any given time, to open the valve to release generator feedstock to the catalyst when the signal corresponds to a catalyst temperature at or above a pre-selected minimum desirable catalyst temperature. Pre-heating the catalyst optimises conversion of generator feedstock by the catalyst.

In a further aspect of the invention, a root vegetable storage facility comprising an apparatus for controlling the ethylene concentration in a root vegetable storage facility as described hereinbefore is provided.

Another aspect of the invention is a method for controlling the ethylene concentration in a root vegetable storage facility comprising the steps of:

A. monitoring the ethylene concentration within the root vegetable storage facility; and
B. releasing ethylene into the root vegetable storage facility when the ethylene concentration falls below a pre-selected minimum desirable ethylene concentration.

The method for controlling the ethylene concentration in a root vegetable storage facility optionally comprises the additional step of arresting release of ethylene into the root vegetable storage facility when the ethylene concentration climbs beyond a pre-selected maximum desirable ethylene concentration.

A further aspect of the invention is a computer program executable when run on a computer to cause the computer to perform the above-mentioned method.

Yet another aspect of the invention is a computer readable carrier medium carrying the aforementioned computer program. The computer readable carrier medium can be selected from, but is not limited to, a floppy disc, a read only memory (ROM), a hard drive and an optical disc.

A further aspect of the invention is a method for controlling sprout growth in a root vegetable stored above ground comprising the steps of:

A. storing a root vegetable under an atmosphere of air at a temperature of less than 9°C for up to 4 months;
B. storing the root vegetable under an atmosphere comprising ethylene at a concentration greater than 4 ppm at a temperature of less than 9°C for up to 12 months; and
C. removing the root vegetable from storage under the said ethylene atmosphere for subsequent packaging.

Optionally the method for controlling sprout growth in a root vegetable stored above ground additionally comprises the step of de-gassing the root vegetable after removal from storage under the ethylene atmosphere and prior to packaging.

The method for controlling sprout growth in a root vegetable stored above ground may additionally include a step of packaging the root vegetable, the step of packaging comprising bagging the root vegetable under a vacuum or an atmosphere comprising either oxygen at a concentration in the range 3-10% v/v and carbon dioxide at a concentration in the range

1-6% v/v, or oxygen at a concentration in greater than or equal to 80% v/v thereby to prolong the natural storage period of the root vegetable.

The temperatures of steps 'A' and/or 'B' are desirably in the range 0-8°C, preferably in the range 2-6°C, more preferably in the range 3-5°C, optimally 3.5°C.

The ethylene concentration is desirably in the range 5-20 ppm, preferably in the range 7-15 ppm, more preferably in the range 9-11 ppm, optimally 10 ppm.

The root vegetable can be stored under an atmosphere of air for 3 months or less, but more preferably for 2 months or less.

The root vegetable can be stored under an atmosphere comprising ethylene for 10 months or less, desirably 8 months or less, optionally 6 months or less or optionally 4 months or less.

The root vegetable can be selected from a potato tuber or an onion bulb.

In a further aspect of the invention, a potato tuber is provided having undergone storage in accordance with the foregoing method for controlling sprout growth in a root vegetable stored above ground.

In another aspect of the invention, an onion bulb is provided having undergone storage in accordance with the foregoing method for controlling sprout growth in a root vegetable stored above ground.

Brief Description of the Figure

The invention will now be exemplified with reference to Figure 1 which shows a block diagram of an apparatus for controlling the atmospheric ethylene concentration in a root vegetable storage facility in accordance with one embodiment of the invention.

Detailed Description of the Invention

In Figure 1, ethanol (101) is metered under gravity to a catalyst (102), comprising alumina silicate pellets, located within an Easy-Ripe (RTM) ethylene generator (Catalytic Generators Inc.), via a restrictor (111) and/or a solenoid valve (103). The catalyst (102) converts ethanol to ethylene whereupon it is vented to the atmosphere (110). The solenoid valve (103) is controlled by an ethylene concentration controller (104) via a three-way switch (109).

The switch (109) connects the ethylene concentration controller (104) to a catalyst temperature controller (107) and the solenoid valve (103), the latter only through a low temperature switch (112). The catalyst temperature controller (107) is only operable when the switch (109) is closed.

The catalyst temperature controller (107) operates a catalyst heater (106), comprising a resistance wire, which heats the catalyst (102) to the required operating temperature of approximately 300-350°C. The catalyst temperature controller (107) monitors a signal from a catalyst temperature sensor (105), which corresponds to the catalyst temperature, against the required operating temperature, the latter being pre-programmed into the catalyst temperature controller (107). If the catalyst temperature falls below the required operating temperature, the catalyst temperature controller (107) switches on the catalyst heater (106). If the catalyst temperature rises above the required operating temperature, the catalyst temperature controller (107) switches off the catalyst heater (106).

The low temperature switch (112) remains in an open position when the catalyst temperature is below a minimum catalyst temperature programmed into the catalyst temperature controller (107). This minimum catalyst temperature is about 25°C below the required catalyst operating temperature.

An ethylene concentration sensor (108) (Type ICA512 R from International Controlled Atmospheres Limited), comprising an electrochemical sensor and conditioning circuits, is in communication with the ethylene concentration controller (104) providing a 4-20 mA signal corresponding to the ethylene concentration in the locality of the ethylene concentration sensor (108). The ethylene concentration sensor (108) is located, often remote from the apparatus, within the root vegetable store where a representative ethylene concentration can be measured.

Operation of the apparatus exemplified in Figure 1 after installation in a store for above ground storage of root vegetables is set out below.

The ethylene generator is loaded with ethanol and activated together with the apparatus. The ethylene concentration controller (104) is programmed with desired minimum and maximum ethylene concentrations.

The ethylene concentration sensor (108) measures the ethylene concentration within the store and transmits a signal corresponding to that ethylene concentration to the ethylene concentration controller (104). The ethylene concentration controller (104) monitors the signal from the ethylene concentration sensor (108) and checks if the signal falls outside the pre-defined minimum and maximum ethylene concentrations. When the signal from the ethylene concentration sensor (108) indicates that the ethylene concentration in the store has fallen below the pre-defined minimum ethylene concentration, the following sequence of events occurs.

The ethylene concentration controller (104) closes the switch (109) to complete a circuit between the ethylene concentration controller (104) and the catalyst temperature controller (107). The catalyst temperature controller (107) is hence activated by the ethylene concentration controller (104) and operates the catalyst heater (106) thereby heating the catalyst to the required operating temperature. Operation of the catalyst heater (106) has been described herein above.

When the catalyst temperature has increased above the programmed minimum catalyst temperature, the catalyst temperature controller (107) closes the low temperature switch (112) thereby permitting the ethylene concentration controller (104) to energise and open the solenoid valve (103) allowing the ethanol (101) to flow into the heated catalyst (102) whereupon it is converted to ethylene.

When the signal from the ethylene concentration sensor (108) indicates that the ethylene concentration in the storage room has risen above the pre-defined maximum ethylene concentration, the ethylene concentration controller (104) opens the switch (109) which de-energises the solenoid valve (103) and deactivates the catalyst temperature controller (107). The flow of the ethanol (101) ceases and the catalyst (102) cools down.

There now follows a description of an experimental trial by the inventors using the aforementioned apparatus and method.

A commercial potato store was filled during the first week of November 2001 with 26 boxes of cultivar *Maris Piper* (27.36 tonnes), 7 boxes of cultivar *King Edward* (7.385 tonnes), 140 boxes of cultivar *Estima* (149.3 tonnes) and 50 boxes of cultivar *Nadine* (48.968 tonnes) potato tubers. An Easy-Ripe (RTM) ethylene generator (Catalytic Generators Inc.) was installed in the store on 7 November 2001. The temperature of the store was set at 3.5°C.

The generator was activated on the 8 November 2001 for 3-4 hours at an ethanol conversion rate of one litre every 48 hours. On expiry of this time period, the ethylene concentration had reached 10 ppm as measured with a Kitagawa tube (a tube containing ethylene concentration sensitive colour indicating crystals). A timer switch was installed on 9 November 2001 to allow the generator to be controlled automatically over a 24 hour period. By 13 November 2001, consistent ethylene concentrations of 10 ppm were achieved by activating the generator for half an hour in every 2 hour period (6 hours daily).

On 29 January 2002, ethylene concentration regulation apparatus in accordance with Figure 1 was installed and activated. Minimum and maximum ethylene concentrations of 8 ppm and 13 ppm respectively were selected.

The results of this trial were that the *Maris Piper* potato tubers started to sprout in mid-December but they did not develop beyond 1-2 mm. There was no visible sprouting with cultivars *King Edward, Estima* and *Nadine* until the end of the trial at the beginning of July 2002. By way of comparison, CIPC treated potato tubers would be expected to have sprouts of less than 1 mm and untreated potato tubers sprout lengths in the range 3-15 mm.

Claims

1. An apparatus for controlling the ethylene concentration in a root vegetable storage facility comprising an ethylene concentration sensor and an ethylene concentration controller, the ethylene concentration controller being configured, in use, to be responsive to a signal from the ethylene concentration sensor, which signal corresponds to the ethylene concentration in the facility at any given time, to initiate the release of ethylene from an ethylene source only when the signal indicates that the ethylene concentration has fallen below a pre-selected minimum desirable ethylene concentration in the facility, thereby to maintain the ethylene concentration above the pre-selected minimum desirable ethylene concentration.

2. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 1 wherein the ethylene concentration controller is additionally configured, in use, to be responsive to the signal from the ethylene concentration sensor to arrest the release of ethylene from an ethylene source when the signal corresponds to an ethylene concentration greater than or equal to a pre-selected maximum ethylene concentration in the facility, thereby to maintain the ethylene concentration within a range defined by the pre-selected minimum and maximum desirable ethylene concentrations.

3. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 1 or claim 2 wherein the ethylene concentration sensor is an electrochemical sensor.

4. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of the preceding claims wherein the pre-selected minimum desirable ethylene concentration is 5 ppm.

5. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of claims 1-3 wherein the pre-selected minimum desirable ethylene concentration is 8 ppm.

6. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of claims 2-5 wherein the pre-selected maximum desirable ethylene concentration is 20 ppm.

7. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of claims 2-5 wherein the pre-selected maximum desirable ethylene concentration is 13 ppm.

8. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of the preceding claims additionally comprising an ethylene source.

9. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 8 wherein the ethylene source is a compressed gas cylinder containing ethylene gas or a mixture of ethylene gas and air or a mixture of ethylene gas and nitrogen.

10. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 8 wherein the ethylene source is a catalytic ethylene generator.

11. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 10 wherein the catalytic ethylene generator comprises a catalyst heater, a catalyst temperature controller and a catalyst temperature sensor, the catalyst temperature controller operating the catalyst heater and being configured to be responsive to a signal from the catalyst

temperature sensor, which signal corresponds to the catalyst temperature at any given time, to switch on the catalyst heater when the signal indicates that the catalyst temperature has fallen below a pre-selected desirable catalyst temperature thereby to maintain the catalyst temperature above the pre-selected desirable catalyst temperature.

12. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 11 wherein the catalyst temperature controller is integral with the ethylene concentration controller.

13. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 11 or claim 12 wherein the catalytic ethylene generator further comprises a valve for controlling the release of generator feedstock to the catalyst, the valve being operated by the ethylene concentration controller, the ethylene concentration controller being configured to open the valve to release generator feedstock to the catalyst only after the catalyst temperature sensor indicates to the catalyst temperature controller that the catalyst temperature is at or above a pre-selected minimum catalyst temperature.

14. An apparatus for controlling the ethylene concentration in a root vegetable storage facility according to claim 11 or claim 12 wherein the catalytic ethylene generator further comprises a valve for controlling the release of generator feedstock to the catalyst, the valve being operated by the catalyst temperature controller, the catalyst temperature controller being configured, in use, to be responsive to a signal from the catalyst temperature sensor, which signal corresponds to the catalyst temperature at any given time, to open the valve to release generator feedstock to the catalyst when the signal corresponds to a catalyst temperature at or above a pre-selected minimum desirable catalyst temperature.

15. A root vegetable storage facility comprising an apparatus for controlling the ethylene concentration in a root vegetable storage facility according to any one of the preceding claims.

16. A method for controlling the ethylene concentration in a root vegetable storage facility comprising the steps of:
    a. monitoring the ethylene concentration within the root vegetable storage facility; and
    b. releasing ethylene into the root vegetable storage facility when the ethylene concentration falls below a pre-selected minimum desirable ethylene concentration.

17. A method for controlling the ethylene concentration in a root vegetable storage facility according to claim 16 comprising the additional step of arresting release of ethylene into the root vegetable storage facility when the ethylene concentration climbs beyond a pre-selected maximum desirable ethylene concentration.

18. A computer program executable when run on a computer to cause the computer to perform the method of claim 16 or claim 17.

19. A computer readable carrier medium carrying the computer program of claim 18.

20. An apparatus for controlling the ethylene concentration in a root vegetable storage facility substantially as described hereinabove with reference to Figure 1.

21. A method for controlling sprout growth in a root vegetable stored above ground comprising the steps of:
    a. storing a root vegetable under an atmosphere of air at a temperature of less than 9°C for up to 4 months;
    b. storing the root vegetable under an atmosphere comprising ethylene at a concentration greater than 4 ppm at a temperature of less than 9°C for up to 12 months; and

c. removing the root vegetable from storage under the said ethylene atmosphere for subsequent packaging.

22. A method for controlling sprout growth in a root vegetable stored above ground according to claim 21 comprising the additional step of de-gassing the root vegetable after removal from storage under the ethylene atmosphere and prior to packaging.

23. A method for controlling sprout growth in a root vegetable stored above ground according to claim 21 or claim 22 additionally including a step of packaging the root vegetable, the step of packaging comprising bagging the root vegetable under a vacuum or an atmosphere comprising either oxygen at a concentration in the range 3-10% v/v and carbon dioxide at a concentration in the range 1-6% v/v, or oxygen at a concentration greater than or equal to 80% v/v thereby to prolong the natural storage period of the root vegetable.

24. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-23 wherein the temperatures of steps 'A' and/or 'B' are in the range 0-8°C.

25. A method for controlling sprout growth in a root vegetable stored above ground according to claim 24 wherein the temperatures are in the range 2-6°C.

26. A method for controlling sprout growth in a root vegetable stored above ground according to claim 25 wherein the temperatures are in the range 3-5°C.

27. A method for controlling sprout growth in a root vegetable stored above ground according to claim 26 wherein the temperatures are 3.5°C.

28. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-27 wherein the ethylene concentration is in the range 5-20 ppm.

29. A method for controlling sprout growth in a root vegetable stored above ground according to claim 28 wherein the ethylene concentration is in the range 7-15 ppm.

30. A method for controlling sprout growth in a root vegetable stored above ground according to claim 29 wherein the ethylene concentration is in the range 9-11 ppm.

31. A method for controlling sprout growth in a root vegetable stored above ground according to claim 30 wherein the ethylene concentration is 10 ppm.

32. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-31 wherein the root vegetable is stored under an atmosphere of air for 3 months or less.

33. A method for controlling sprout growth in a root vegetable stored above ground according to claim 32 wherein the root vegetable is stored under an atmosphere of air for 2 months or less.

34. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-33 wherein the root vegetable is stored under an atmosphere comprising ethylene for 10 months or less.

35. A method for controlling sprout growth in a root vegetable stored above ground according to claim 34 wherein the root vegetable is stored under an atmosphere comprising ethylene for 8 months or less.

36. A method for controlling sprout growth in a root vegetable stored above ground according to claim 35 wherein the root vegetable is stored under an atmosphere comprising ethylene for 6 months or less.

37. A method for controlling sprout growth in a root vegetable stored above ground according to claim 36 wherein the root vegetable is stored under an atmosphere comprising ethylene for 4 months or less.

38. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-37 wherein the root vegetable is a potato tuber.

39. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 21-37 wherein the root vegetable is an onion bulb.

40. A potato tuber having undergone storage in accordance with the method of claim 38.

41. An onion bulb having undergone storage in accordance with the method of claim 39.

Amendments to the claims have been filed as follows

1. A method for controlling sprout growth in a root vegetable stored above ground comprising the steps of:
   a. storing a root vegetable under an atmosphere of air at a temperature of less than 9°C for up to 4 months;
   b. storing the root vegetable under an atmosphere comprising ethylene at a concentration greater than 4 ppm at a temperature of less than 9°C for up to 12 months; and
   c. removing the root vegetable from storage under the said ethylene atmosphere for subsequent packaging.

2. A method for controlling sprout growth in a root vegetable stored above ground according to claim 1 comprising the additional step of de-gassing the root vegetable after removal from storage under the ethylene atmosphere and prior to packaging.

3. A method for controlling sprout growth in a root vegetable stored above ground according to claim 21 or claim 22 additionally including a step of packaging the root vegetable, the step of packaging comprising bagging the root vegetable under a vacuum or an atmosphere comprising either oxygen at a concentration in the range 3-10% v/v and carbon dioxide at a concentration in the range 1-6% v/v, or oxygen at a concentration greater than or equal to 80% v/v thereby to prolong the natural storage period of the root vegetable.

4. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 1-3 wherein the temperatures of steps 'A' and/or 'B' are in the range 0-8°C.

5. A method for controlling sprout growth in a root vegetable stored above ground according to claim 4 wherein the temperatures are in the range 2-6°C.

6. A method for controlling sprout growth in a root vegetable stored above ground according to claim 5 wherein the temperatures are in the range 3-5°C.

7. A method for controlling sprout growth in a root vegetable stored above ground according to claim 6 wherein the temperatures are 3.5°C.

8. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 1-7 wherein the ethylene concentration is in the range 5-20 ppm.

9. A method for controlling sprout growth in a root vegetable stored above ground according to claim 8 wherein the ethylene concentration is in the range 7-15 ppm.

10. A method for controlling sprout growth in a root vegetable stored above ground according to claim 9 wherein the ethylene concentration is in the range 9-11 ppm.

11. A method for controlling sprout growth in a root vegetable stored above ground according to claim 30 wherein the ethylene concentration is 10 ppm.

12. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 1-11 wherein the root vegetable is stored under an atmosphere of air for 3 months or less.

13. A method for controlling sprout growth in a root vegetable stored above ground according to claim 12 wherein the root vegetable is stored under an atmosphere of air for 2 months or less.

14. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 1-13 wherein the root

vegetable is stored under an atmosphere comprising ethylene for 10 months or less.

15. A method for controlling sprout growth in a root vegetable stored above ground according to claim 14 wherein the root vegetable is stored under an atmosphere comprising ethylene for 8 months or less.

16. A method for controlling sprout growth in a root vegetable stored above ground according to claim 15 wherein the root vegetable is stored under an atmosphere comprising ethylene for 6 months or less.

17. A method for controlling sprout growth in a root vegetable stored above ground according to claim 16 wherein the root vegetable is stored under an atmosphere comprising ethylene for 4 months or less.

18. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 11-17 wherein the root vegetable is a potato tuber.

19. A method for controlling sprout growth in a root vegetable stored above ground according to any one of claims 11-17 wherein the root vegetable is an onion bulb.

20. A potato tuber having undergone storage in accordance with the method of claim 18.

21. An onion bulb having undergone storage in accordance with the method of claim 39.

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Claims searched: 21-41

Examiner: Keith Kennett
Date of search: 15 December 2003

Patents Act 1977 : Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	21	GB 2163637 A (JOHNSON MATTHEY) see Example

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

A2D

Worldwide search of patent documents classified in the following areas of the IPC[7]:

A23B

The following online and other databases have been used in the preparation of this search report :

Online: EPODOC, WPI, JAPIO

Application No: GB 0307897.9 22 **Examiner:** Keith Kennett
Claims searched: 1-20 **Date of search:** 21 August 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1,4-8,15 16	JP 09023740 A (NORIN) see abstract
X	1,8,16,18 19	ES 2149688 A (TECNIDEX) see abstract
X	1,8,15,16	WO 01/71258 A2 (GABLER) see claims 1 and 2
A	1,15,16	WO 93/02563 A1 (OULTON) see claims 1,4 and 7

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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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A2D

Worldwide search of patent documents classified in the following areas of the IPC[7]:

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