

Description

Title

REFRIGERATOR

Field

[0001]

The present invention relates to a refrigerator.

Background

[0002]

In a conventionally known refrigerator (for example, see PTL 1), an irradiation board on which multiple light-emitting diode components of three colors including red, blue, and green are arranged is provided in a vegetable compartment of the refrigerator, the irradiation board is partitioned into multiple areas, and the refrigerator is provided with selection means for changing the combination of colors emitted by the light-emitting diode components for each area.

Citation List

Patent Literature

[0003]

[PTL 1] JP 2005-065622 A

Summary

Technical Problem

[0004]

However, the conventional refrigerator described in PTL 1 does not take into account the characteristic of each of the red, blue, and green lights, that is, the optical wavelengths, in photosynthesis of plant. Accordingly, light having a needlessly large amount of light-emitting energy may be emitted to cause a certain degree of photosynthesis, or light-emitting energy may be partially converted into heat and energy may be consumed wastefully.

[0005]

The invention has been made to solve such problems, and provides a refrigerator that can utilize light-emitting energy efficiently without consuming extra energy, and can prompt photosynthesis of stored green goods such as vegetables (particularly leaf vegetables).

Solution to Problem

[0006]

A refrigerator according to the present invention includes: a storage compartment configured to store food; and a light-emitting part configured to be able to emit visible light to an inside of the storage compartment, the light-emitting part including: a first light source configured to emit light having a first wavelength of a visible light region as a center wavelength; and a second light source configured to emit light having a second wavelength of the visible light region shorter than the first wavelength as the center wavelength, the light-emitting part configured to emit, in an emission step of emitting light, light with a first radiant intensity from the first light source, and simultaneously,

light with a second radiant intensity different from the first radiant intensity from the second light source.

Advantageous Effects of Invention

[0007]

The refrigerator of the invention can utilize light-emitting energy efficiently without consuming extra energy, and can prompt photosynthesis of stored green goods such as vegetables (particularly leaf vegetables).

Brief Description of the Drawings

[0008]

Fig. 1 is a front view of a refrigerator relating to Embodiment 1 of the present invention.

Fig. 2 is a longitudinal section of the refrigerator relating to Embodiment 1 of the present invention.

Fig. 3 is an enlarged view of a vegetable compartment part of Fig. 2.

Fig. 4 is a diagram showing a configuration of a light-emitting part included in the refrigerator relating to Embodiment 1 of the present invention.

Fig. 5 is a block diagram showing a configuration of a control system of the refrigerator relating to Embodiment 1 of the present invention.

Fig. 6 is a time chart of light emission control by each light source included in the light-emitting part of the refrigerator relating to Embodiment 1 of the present invention.

Fig. 7 is a flow chart showing a flow of light emission control of the refrigerator relating to Embodiment 1 of the present invention.

Fig. 8 is a diagram showing an example of a relationship between photosynthetic photon density and the rate of change of the vitamin C amount when a cabbage is stored for three days.

Fig. 9 is a diagram showing an example of amounts of energy of green light and red light having equivalent photon flux density.

Fig. 10 is a diagram showing a relationship between an emission energy ratio R/G between green light and red light, and the total energy of green light and red light.

Fig. 11 is a diagram showing an example of energy amounts that result in the same total photon flux density as Fig. 9 when the energy amount ratio of green light to red light is 1:2.

Fig. 12 is a diagram showing an example of comparison of the amounts of vitamin C when a cabbage is stored for three days under multiple light emission conditions.

Fig. 13 is a time chart of light emission control by the light sources included in the light-emitting part of the refrigerator relating to Embodiment 1 of the present invention, and opening and closing of a vegetable compartment door.

Fig. 14 is a diagram showing a configuration of a light-emitting part included in a refrigerator relating to Embodiment 2 of the present invention.

Fig. 15 is a time chart of light emission control of each light source included in the light-emitting part of the refrigerator relating to Embodiment 2 of the present invention.

Fig. 16 is a flowchart showing a flow of light emission control of the refrigerator relating to Embodiment 2 of the present invention.

Fig. 17 is a diagram showing an example of comparison of the amounts of vitamin C when a cabbage is stored for three days under multiple light emission conditions.

Fig. 18 is a diagram showing a configuration of a light-emitting part included in a refrigerator relating to Embodiment 3 of the present invention.

Description of Embodiments

[0009]

Embodiments of the invention will be described with reference to the accompanying drawings. In the drawings, the same or corresponding parts are assigned the same reference numeral, and overlapping description will be simplified or omitted as appropriate. Note that the present invention is not limited to the following embodiments, and various changes can be made without departing from the gist of the invention.

[0010]

Embodiment 1

Figs. 1 to 13 relate to Embodiment 1 of the invention, where Fig. 1 is a front view of a refrigerator, Fig. 2 is a longitudinal section of the refrigerator, Fig. 3 is an enlarged view of a vegetable compartment part of Fig. 2, Fig. 4 is a diagram showing a configuration of a light-emitting part included in the refrigerator, Fig. 5 is a block diagram showing a configuration of a control system of the refrigerator, Fig. 6 is a time chart of light emission control by each light source included in the light-emitting part of the refrigerator, Fig. 7 is a flow chart showing a flow of light emission control of the refrigerator, Fig. 8 is a diagram showing an example of a relationship between photosynthetic photon density and the rate of change of the vitamin C amount when a cabbage is stored for three days, Fig. 9 is a diagram showing an example of amounts of energy of green light and red light having equivalent photon flux density, Fig. 10 is a

diagram showing a relationship between an emission energy ratio R/G between green light and red light, and the total energy of green light and red light, Fig. 11 is a diagram showing an example of energy amounts that result in the same total photon flux density as Fig. 9 when the energy amount ratio of green light to red light is 1:2, Fig. 12 is a diagram showing an example of comparison of the amounts of vitamin C when a cabbage is stored for three days under multiple light emission conditions, Fig. 13 is a time chart of light emission control by the light sources included in the light-emitting part of the refrigerator, and opening and closing of a vegetable compartment door.

[0011]

Note that in the drawings, the dimensional relation, shape, and the like of the components may differ from those in reality. In addition, the positional relations (e.g., up-down relation) among the components are basically those when the refrigerator is installed in a usable state.

[0012]

(Configuration of Refrigerator)

As shown in Fig. 2, a refrigerator 1 of Embodiment 1 of the invention has a thermal insulation case 90. The thermal insulation case 90 has an open front face (front), and has an inner storage space. The thermal insulation case 90 has an outer case, an inner case, and a heat insulating material. The outer case is made of steel. The inner case is made of resin. The inner case is arranged inside the outer case. The heat insulating material is urethane foam, for example, and fills a space between the outer case and the inner case. The storage space formed inside the thermal insulation case 90 is divided into multiple storage compartments for storing food, by one or multiple partition members.

[0013]

As shown in Figs. 1 and 2, in the embodiment, the refrigerator 1 includes, as multiple storage compartments, a cold room 100, a switchable room 200, an ice making room 300, a freezer room 400, and a vegetable compartment 500, for example. The storage compartments are vertically arranged in a four-step configuration in the thermal insulation case 90.

[0014]

The cold room 100 is arranged in the uppermost step of the thermal insulation case 90. The switchable room 200 is arranged on one of the right and left sides below the cold room 100. The cooling temperature range of the switchable room 200 is switchable by selecting any of multiple temperature ranges. Examples of the multiple temperature ranges selectable as the cooling temperature range of the switchable room 200 include a freezing temperature range (e.g., about -18°C), a refrigeration temperature range (e.g., about 3°C), a chilled temperature range (e.g., about 0°C), and a soft freezing temperature range (e.g., about -7°C). The ice making room 300 is arranged adjacent to and side by side with the switchable room 200, that is, on the other of the right and left sides below the cold room 100.

[0015]

The freezer room 400 is arranged below the switchable room 200 and the ice making room 300. The freezer room 400 is used mainly for freezing a storage target for a relatively long period of time. The vegetable compartment 500 is arranged in the lowermost step below the freezer room 400. The vegetable compartment 500 is provided mainly to store vegetables and large volume (e.g., 2L) plastic bottles.

[0016]

A rotary cold room door 7 that opens and closes an opening formed in a front face of the cold room 100 is provided in the opening. In the embodiment, the cold room door 7 is a double swing type (double doored type), and is made up of a right door 7a and a left door 7b. An operation panel 6 is provided on an outer surface of the cold room door 7 (e.g., left door 7b) on the front face of the refrigerator 1. The operation panel 6 includes an operation part 6a and a display part 6b. The operation part 6a is an operation switch for setting the cooling temperature of each storage compartment and an operation mode (e.g., defrost mode) of the refrigerator 1. The display part 6b is a liquid crystal display that displays information such as the temperature of each storage compartment. The operation panel 6 may include a touch panel that serves as both of the operation part 6a and the display part 6b.

[0017]

Each of the storage compartments (switchable room 200, ice making room 300, freezer room 400, and vegetable compartment 500) other than the cold room 100 is opened closed by a pullout type door. The pullout type door can be opened and closed in the depth direction (front-rear direction) of the refrigerator 1, by sliding a frame fixed to the door along rails formed horizontally on right and left inner wall faces of each storage compartment.

[0018]

A switchable room storage case 201 and a freezer room storage case 401 that can store food and the like are stored in a freely drawable manner, inside the switchable room 200 and the freezer room 400, respectively. Similarly, an upper storage case 11 and a lower storage case 10 that can store food and the like are stored in a freely drawable manner, inside the vegetable compartment 500.

[0019]

(Cooling Mechanism)

The refrigerator 1 includes a refrigeration cycle circuit that cools air supplied to each storage compartment. The refrigeration cycle circuit is made up of a compressor 2, a condenser (not shown), a diaphragm device (not shown), and a cooler 3, for example. The compressor 2 compresses and discharges a coolant in the refrigeration cycle circuit. The condenser condenses the coolant discharged from the compressor 2. The diaphragm device expands the coolant having flowed out from the condenser. The cooler 3 cools air to be supplied to each storage compartment by the coolant expanded in the diaphragm device. The compressor 2 is arranged in a lower part on the rear side of the refrigerator 1, for example.

[0020]

An air channel 5 for supplying the air cooled by the refrigeration cycle circuit to each storage compartment is formed in the refrigerator 1. The air channel 5 is mainly arranged on the rear side in the refrigerator 1. The cooler 3 of the refrigeration cycle circuit is arranged in the air channel 5. Additionally, a blower fan 4 for sending the air cooled in the cooler 3 to each storage compartment is also provided in the air channel 5.

[0021]

When the blower fan 4 operates, the air (cold air) cooled in the cooler 3 is sent to the freezer room 400, the switchable room 200, the ice making room 300, and the cold room 100 through the air channel 5, and cools the inside of the storage compartments. The vegetable compartment 500 is cooled by introducing return cold air from the cold room 100 into the vegetable compartment 500, through a cold room-return air channel. The cold air having cooled the vegetable compartment 500 is returned into the air channel

5 including the cooler 3, through a vegetable compartment-return air channel (the return air channels are not shown). Then, the cold air is cooled again by the cooler 3, and is circulated inside the refrigerator 1.

[0022]

An unillustrated damper is provided in an intermediate part of the air channel 5 that leads to each of the storage compartments. Each damper opens and closes the part of the air channel 5 that leads to each storage compartment. The supply amount of cold air blown into each storage compartment can be adjusted by varying the open and closed states of the damper. In addition, the temperature of cold air can be adjusted by controlling operation of the compressor 2.

[0023]

The refrigeration cycle circuit made up of the compressor 2 and the cooler 3, the blower fan 4, the air channel 5, and the dampers provided in the above manner form cooling means for cooling the inside of the storage compartments.

[0024]

A controller 8 is stored in an upper part on the rear side of the refrigerator 1, for example. The controller 8 includes a control circuit and other parts for performing various controls necessary for operation of the refrigerator 1. An example of a control circuit included in the controller 8, is a circuit for controlling operation of the compressor 2 and the blower fan 4 and the opening of the dampers, on the basis of the temperature inside each storage compartment, information input to the operation panel 6, and the like. In other words, the controller 8 controls operation of the refrigerator 1 by controlling the aforementioned cooling means and other parts. Note that the temperature inside each

storage compartment can be detected by a thermistor (not shown), for example, provided in each storage compartment.

[0025]

(Configuration of Vegetable compartment)

Fig. 3 is a cross-sectional view of the vegetable compartment 500 part included in the refrigerator 1. The vegetable compartment 500 is a storage compartment that stores food, and particularly, vegetables. The lower storage case 10 is supported by a frame (not shown) of the vegetable compartment door 9. The upper storage case 11 is placed on the upper side of the lower storage case 10. When the vegetable compartment door 9 is pulled out to the front, the lower storage case 10 and the upper storage case 11 are pulled out to the front integrally with the vegetable compartment door 9. When only the upper storage case 11 is slid to the rear while the vegetable compartment door 9 is pulled out, only the lower storage case 10 is left in the pulled out state. While the lower storage case 10 alone is pulled out, food can be placed in and taken out of the lower storage case 10.

[0026]

A door opening and closing detection switch 12, a thermistor 13, and a light-emitting part 14 are provided inside the vegetable compartment 500. The door opening and closing detection switch 12 is configured to detect open and closed states of the vegetable compartment door 9. The door opening and closing detection switch 12 is provided at the edge of a front opening of the vegetable compartment 500, in a position facing the vegetable compartment door 9.

[0027]

The thermistor 13 and the light-emitting part 14 are attached to a rear face part inside the vegetable compartment 500. The thermistor 13 detects the temperature inside the vegetable compartment 500. The light-emitting part 14 can emit visible light into the vegetable compartment 500 which is a storage compartment. In the embodiment, an opening 15 is formed in a part of a rear face of the lower storage case 10 that faces the light-emitting part 14. The light-emitting part 14 can emit visible light into the lower storage case 10 through the opening 15. Note that a material that allows passage of the visible light emitted from the light-emitting part 14 may be used at least in the part of the lower case 10 corresponding to the opening 15.

[0028]

(Configuration of Light-emitting part)

Next, a configuration of the light-emitting part 14 will further be described with reference to Fig. 4. As shown in Fig. 4, the light-emitting part 14 includes two types of light sources which are a first light source 16a and a second light source 16b. As mentioned earlier, the light-emitting part 14 can emit visible light. Hence, the light-emitting part 14 includes a visible light source that emits visible light. The first light source 16a and the second light source 16b are visible light sources. The first light source 16a and the second light source 16b can each be turned on and off independently.

[0029]

The first light source 16a emits light having a first wavelength as the center wavelength. The second light source 16b emits light having a second wavelength as the center wavelength. The first wavelength and the second wavelength both belong to the same visible light region. Note, however, that the second wavelength is different from the first wavelength.

[0030]

Specifically, the first wavelength which is the center wavelength of the first light source 16a is not shorter than 500 nm and not longer than 700 nm, and is preferably not shorter than 600 nm and not longer than 700 nm. That is, the light emitted from the first light source 16a is red. Specifically, a red LED may be used as the first light source 16a, for example.

[0031]

Meanwhile, the second wavelength which is the center wavelength of the second light source 16b is not shorter than 500 nm and not longer than 560 nm. That is, the light emitted from the second light source 16b is green. Specifically, a green LED may be used as the second light source 16b, for example. In other words, the second wavelength is a wavelength within the visible light region and shorter than the first wavelength.

[0032]

The first light source 16a emits light with a first radiant intensity. The second light source 16b emits light with a second radiant intensity. The second radiant intensity is an intensity different from the first radiant intensity. In the embodiment, the second radiant intensity is lower than the first radiant intensity. To be specific, the ratio of the first radiant intensity to the second radiant intensity is 2:1.

[0033]

The light quantity and number of each of the elements that forms the first light source 16a and the second light source 16b provided in the light-emitting part 14 are selected, such that the radiant intensity of the first light source 16a and the second light source 16b satisfy the above relationship. Specifically, in the embodiment, two

elements are provided to form the first light source 16a, and one element is provided to form the second light source 16b in the light-emitting part 14.

[0034]

(Control System of Refrigerator)

Fig. 5 is a block diagram showing a functional configuration of a control system of the refrigerator 1. In particular, Fig. 5 shows parts related to control of the vegetable compartment 500. The controller 8 includes a microcomputer, for example, and includes a processor (CPU) 8a and a memory 8b. The controller 8 controls the refrigerator 1 by causing the processor (CPU) 8a to execute a program stored in the memory 8b, and thereby performing preset processing.

[0035]

A detection signal of the temperature inside the vegetable compartment 500 is input to the controller 8 from the thermistor 13. An operation signal from the operation part 6a of the operation panel 6 is also input to the controller 8. Moreover, a detection signal from the door opening and closing detection switch 12 is also input to the controller 8.

[0036]

The controller 8 performs processing based on the input signal, and controls operation of the compressor 2, the blower fan 4, and other parts to maintain the temperature inside the vegetable compartment 500 at a preset temperature. The controller 8 also outputs a display signal to the display part 6b of the operation panel 6.

[0037]

Further, the controller 8 also outputs a control signal to the light-emitting part 14 to control light emission operation of the light-emitting part 14. As mentioned earlier,

the light-emitting part 14 includes the first light source 16a and the second light source 16b. The controller 8 can control ON and OFF of each of the first light source 16a and the second light source 16b included in the light-emitting part 14.

[0038]

(Control of Light-emitting part)

Next, light emission operation control of the light-emitting part 14 by the controller 8 will be described with reference to Fig. 6. The controller 8 controls operation of the light-emitting part 14 to alternately repeat emission step of causing the light-emitting part 14 to emit light including visible light, and non-emission step of not causing the light-emission part 14 to emit light including visible light. That is, according to control by the controller 8, the light-emitting part 14 alternately repeats emission step of emitting light, and non-emission step of not emitting light.

[0039]

In emission step, the first light source 16a and the second light source 16b are both turned on. In the non-emission step, neither of the first light source 16a or the second light source 16b is turned on. The duration of each step is set in advance. In this connection, the duration of emission step is defined as $\Delta T1$, and the duration of non-emission step is defined as $\Delta T2$.

[0040]

Thus, the controller 8 controls the light-emitting part 14, so that emission step and non-emission step are performed in this order. Then, after completion of non-emission step, the steps are repeated again from emission step in the aforementioned order. Accordingly, a time ΔT taken for one cycle in which once of each step is performed in sequence is the total of $\Delta T1$ and $\Delta T2$.

[0041]

The controller 8 controls the light-emitting part 14, so that emission step and non-emission step are repeated alternately in a 24 hour or shorter cycle. That is, ΔT is set to 24 hours or shorter. Then, the light-emitting part 14 repeats emission step and non-emission step alternately in the 24 hour or shorter cycle.

[0042]

Meanwhile, the duration $\Delta T2$ of non-emission step is set to be not longer than the duration $\Delta T1$ of emission step. Specifically, as an example of duration of the steps satisfying the above condition, $\Delta T1$ is set to 12 hours, and $\Delta T2$ is set to 12 hours. In this case, ΔT is 24 hours.

[0043]

A sequential flow according to control of the light-emitting part 14 of the vegetable compartment 500 included in the refrigerator 1 configured in the above manner will be described with reference to the flowchart of Fig. 7. When the refrigerator 1 is powered on, first, in step S101, the controller 8 turns on the first light source 16a and the second light source 16b of the light-emitting part 14. In next step S102, the controller 8 resets the value of a timer t measuring elapsed time to zero, and starts measuring by the timer.

[0044]

Then, in next step S103, the controller 8 checks whether the elapsed time t of the timer has reached $\Delta T1$. If the elapsed time t of the timer has not reached $\Delta T1$, the checking in step S103 is repeated until the elapsed time t of the timer reaches $\Delta T1$. Thereafter, when the elapsed time t of the timer reaches $\Delta T1$, the processing proceeds to step S104. Steps S101 to S103 described above form emission step.

[0045]

In step S104, the controller 8 turns off the first light source 16a and the second light source 16b of the light-emitting part 14. Then, the processing proceeds to step S105, and the controller 8 resets the value of the timer t measuring elapsed time to zero, and starts measuring by the timer.

[0046]

In next step S106, the controller 8 checks whether the elapsed time t of the timer has reached $\Delta T2$. If the elapsed time t of the timer has not reached $\Delta T2$, the checking in step S106 is repeated until the elapsed time t of the timer reaches $\Delta T2$. Thereafter, when the elapsed time t of the timer reaches $\Delta T2$, the processing returns to step S101, and the above steps are repeated. Steps S104 to S106 described above form non-emission step.

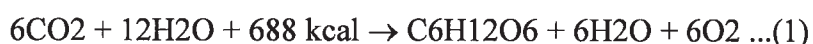
[0047]

(Effect of Light Emission)

Next, expected effects of the above-mentioned light emission in the light-emitting part 14 will be described. First, photosynthetic reaction of plant will be described.

The photosynthetic reaction can be expressed by the following formula (1).

[0048]



[0049]

In formula (1), CO_2 indicates carbon dioxide, H_2O indicates water, 688 kcal indicates light energy, and $\text{C}_6\text{H}_{12}\text{O}_6$ indicates glucose.

[0050]

The photosynthetic reaction of formula (1) causes plant to use light energy to generate oxygen and sugar from carbon dioxide included in the air, and water in the plant. The reaction is formed of two stages. In the first stage, light energy absorbed by pigments such as chlorophyll included in leaves and the like is used to decompose water into hydrogen and oxygen, and chemical energy is stored by the effect of enzyme protein. In the second stage, electron, hydrogen ion, and carbon dioxide included in the air are used to synthesize glucose. A vegetable having increased glucose has better shelf stability, and generates vitamin C from glucose.

[0051]

To activate photosynthesis, the light emitted into the vegetable compartment 500 needs to be effective for photosynthesis. The absorption spectrum of chlorophyll has red (around 660 nm) and blue (around 450 nm) two light absorption peaks, and these wavelengths are known to be particularly effective for photosynthesis.

[0052]

Additionally, although green (500 to 600 nm) has low absorption rate by chlorophyll, the light is scattered inside a leaf and is more likely to meet chlorophyll, whereby the absorption rate in the leaf as a whole is increased. Accordingly, chlorophyll in the entire leaf can be activated by emitting both of red light that coincides with the absorption spectrum and green light as auxiliary light. Thus, photosynthesis can be performed effectively.

[0053]

Here, the amount of light usable for photosynthesis can be measured by photosynthetic photon flux density (unit: $\mu\text{mol}/(\text{m}^2\cdot\text{s})$). Photosynthetic photon flux

density indicates the number of photons per second per square meter in the wavelength band 400 nm to 700 nm that is absorbable by chlorophyll.

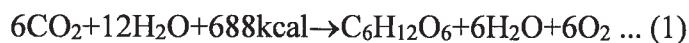
[0054]

Fig. 8 shows a graph indicating measurement results of the rate of change of the amount of vitamin C in a vegetable stored in the vegetable compartment for three days and having undergone photosynthesis, relative to photosynthetic photon flux density. It can be understood from the graph of Fig. 8 that the larger the photosynthetic photon flux density, the more photosynthesis is prompted and vitamin C included in the vegetable increases.

[0055]

Here, a number of photons n [mol] included in the emitted light and light-emission energy Q [J] are known to have a certain relationship indicated by the following formula (2).

[0056]



[0057]

Note that in formula (2), e indicates energy [J] of a single photon, N_A indicates the Avogadro constant ($= 6.02 \times 10^{23}$), λ indicates a wavelength [nm], h indicates the Planck constant ($= 6.63 \times 10^{-34}$) [Js], and C indicates the speed of light ($= 3.00 \times 10^8$) [m/s].

[0058]

As can be seen from formula (2), the longer the wavelength of emitted light, the larger the number of photons included in the light.

[0059]

Fig. 9 is an example showing the necessary energy amount when green light and red light have the same photon flux density. Red light can obtain the same photon flux density with a lower light-emission energy than green light. Fig. 10 shows a relationship between an emission energy ratio R/G between green light and red light, and the total energy of green light and red light, when the total photon flux density of green light and red light is an arbitrary constant value. When the total photon flux density is constant, the larger the emission energy ratio R/G of red light to green light, the smaller the total energy.

[0060]

That is, an equivalent total photon flux density can be obtained with a smaller total energy, when the ratio of red light is higher than green light. Additionally, it can be understood from Fig. 10 that an equivalent total photon flux density can be obtained with a sufficiently small total energy, when the emission energy ratio R/G is not smaller than 2.

[0061]

Hence, Fig. 11 shows an example of energy amounts that result in the same total photon flux density as Fig. 9 when the emission energy ratio of green light to red light is 1:2. When the emission energy ratio of green light to red light is thus set to 1:2, while the total photon flux density is $35 + 85 = 120$ [$\mu\text{mol}/(\text{m}^2\cdot\text{s})$] as in the example of Fig. 9, the total light-emission energy is $8 + 16 = 24$ [W/m^2], which is smaller than 26 [W/m^2] of the example of Fig. 9.

[0062]

As mentioned earlier, in Embodiment 1 of the invention, the first light source 16a emits red light with the first radiant intensity. Meanwhile, the second light source 16b emits green light with the second radiant intensity. The second radiant intensity is an intensity different from the first radiant intensity. In the embodiment, the second radiant intensity is lower than the first radiant intensity, and more specifically, the ratio of the first radiant intensity to the second radiant intensity is set to 2:1.

[0063]

In emission step of emitting light, the light-emitting part 14 emits light from the first light source 16a with the first radiant intensity, and simultaneously emits light from the second light source 16b with the second radiant intensity. Accordingly, a larger photon flux density can be obtained from a smaller total light-emission energy, whereby photosynthesis of the vegetables irradiated with light can be prompted efficiently.

[0064]

Note that the above description has been given of a case where the emission energy amount of light emitted from the first light source 16a and the second light source 16b are fixed, and elements that form the first light source 16a and the second light source 16b in such a manner as to satisfy the aforementioned relationship of the light-emission energy amount are provided in advance in the light-emitting part 14. In this regard, the invention is not limited to this configuration, and the first light source 16a and the second light source 16b may be capable of varying the light amount, and the controller 8 may adjust the light amount of the first light source 16a and the second light source 16b to satisfy the aforementioned relationship of the light-emission energy amount, for example.

[0065]

Next, the circadian rhythm of plant autonomously maintains the 24 hour cycle, even under a condition where time information such as the brightness cycle of light is not given. However, when green goods such as vegetables are stored in a dark environment without emission of light, the green goods do not perform photosynthesis, and therefore effects like improved shelf stability or increased nutrients cannot be obtained. On the other hand, when green goods are stored in a bright environment with continuous emission of light, the green goods perform photosynthesis, but may be incapable of generating sufficient nutrients, or may cause trouble such as decrease in the photosynthesis speed or photosynthesis capacity.

[0066]

Against this background, in the refrigerator 1 of the invention, as mentioned earlier, the light-emitting part 14 of the vegetable compartment 500 alternately repeats emission step of emitting light including visible light and non-emission step of not emitting light including visible light, into the lower storage case 10 of the vegetable compartment 500.

[0067]

For this reason, the inside of the lower storage case 10 varies over time, between a bright phase of a bright environment when visible light is emitted, and a dark phase of a dark environment when visible light is not emitted. In other words, the inside of the lower storage case 10 forms an environment simulating natural variation in light amount, caused by the sun coming up in the morning and going down at night. Accordingly, it is possible to prompt plant such as green goods placed in the lower storage case 10 to perform actions such as photosynthesis, according to the circadian rhythm.

[0068]

The circadian rhythm of plant is approximately a 24 hour cycle corresponding to the time from morning to night and then to morning again. However, the circadian rhythm of plant is characterized in that the rhythm phase is varied under influence of ambient light. For example, if light is emitted to form a bright environment in a dark environment, the rhythm phase shifts to the morning side. By using this characteristic, the duration of non-emission step is made shorter than visible light emission step, that is, the dark phase of not emitting light is made shorter than the bright phase of emitting light to set the light emission cycle to 24 hours or shorter. Thus, the proportion of time for the green goods in the lower storage case 10 to perform photosynthesis during storage can be enlarged. Additionally, by enlarging the proportion of time to perform photosynthesis during storage, nutrients such as sugar and vitamin C of the green goods can be generated more efficiently.

[0069]

Hereinafter, referring to Fig. 12, a description will be given by use of specific comparative examples, of what difference occurs in the amount of nutrient (vitamin C) included in green goods, when the green goods are stored under multiple different light emission conditions as described above. Fig. 12 is a graph comparing the amounts of vitamin C after storing a cabbage for three days under multiple different light emission conditions. The amount of vitamin C is expressed as the rate of change by assuming that an initial amount of vitamin C before storage is 100. As for the light emission conditions, the light intensity is the same, and the color included in the emitted light and the emission time per day are varied.

[0070]

In "No emission" where light was not emitted all day, the amount of vitamin C after storage decreased from the initial state (left-most graph in Fig. 12). On the other hand, under all of the conditions where light was emitted, the amount of vitamin C after storage increased from the initial state. As compared to a case where light was continuously emitted all day (center graph in Fig. 12), the amount of vitamin C after storage increased even more when a no light emission time, that is, a dark phase was provided and light emission according to the circadian rhythm was performed (right-most graph in Fig. 12).

[0071]

By thus emitting light having an appropriate wavelength according to the circadian rhythm of the green goods, photosynthesis and generation of nutrients can be performed efficiently, and effects of improved shelf stability and increased nutrient in the stored vegetables can be achieved. In other words, according to the refrigerator 1 of the invention, by emitting light simulating the movement of natural light, the circadian rhythm of green goods can be utilized to control actions such as photosynthesis of the green goods, whereby generation of nutrients by photosynthesis can be prompted and undesired transpiration can be suppressed, to store vegetables in high quality.

[0072]

(Other Example of Control of Light-emitting part)

In the control of the light-emitting part 14 described above, around what time of the day emission step and non-emission step are performed has not been mentioned in particular. Here, as another example of control of the light-emitting part 14, a description will be given, with reference to Fig. 13, of an example of performing control

of the light-emitting part 14 such as the time of performing non-emission step, according to the detection result of open and closed states of the vegetable compartment door 9.

[0073]

As mentioned earlier, the vegetable compartment door 9 is a door that can open and close the vegetable compartment 500 which is a storage compartment. In addition, the door opening and closing detection switch 12 is detection means for detecting opening and closing of the vegetable compartment door 9. The controller 8 measures the number of times of opening and closing of the vegetable compartment door 9 detected by the door opening and closing detection switch 12, per given time, that is, per preset reference time. Here, the reference time, is the duration $\Delta T2$ of non-emission step, for example. Then, the controller 8 controls the light-emitting part 14, so that non-emission step is performed at a time when the number of times the vegetable compartment door 9 has been opened and closed per given time is not larger than the preset number of times.

[0074]

The door of the refrigerator 1 is opened and closed frequently during preparation of a meal or before and after shopping, for example, and is not opened and closed when the user is asleep or has gone out, for example. Hence, in everyday life, variation in the number of times of opening and closing of the door develops a certain pattern in a single day, and is predictable. For this reason, the controller 8 measures the number of times of opening and closing of the vegetable compartment door 9, and stores the time when the number of opening and closing of the door per given time is small in an unillustrated storage or the like. Then, by starting non-emission step at the stored time from the next day forward, or 24 hours after storing the time, non-emission step can be performed at a time when the number of opening and closing is small.

[0075]

If the vegetable compartment door 9 is opened and closed in the middle of non-emission step, the phase of the circadian rhythm of the stored green goods may be varied under influence of light outside the refrigerator 1. Hence, by performing non-emission step at a time when the number of opening and closing of the vegetable compartment door 9 is small, the dark phase when light is not emitted onto the green goods inside the lower storage case 10 can be ensured, and light emission control according to the circadian rhythm can be performed efficiently.

[0076]

Note that the user may be allowed to switch between performing and stopping (keeping light-emitting part 14 off at all times) light emission control by the light-emitting part 14, by operating the operation part 6a of the operation panel 6 provided on the cold room door 7. By allowing the user to select whether to perform control to turn on the light-emitting part 14 by use of the operation panel 6, "stop" may be selected when not much green goods are stored or when the vegetable compartment is not used for a long time, for example, to keep the light-emitting part 14 off at all times, and suppress energy consumption while also providing the same usability as a normal refrigerator 1.

[0077]

Also, during light emission control, "light emission," for example, may be displayed on the display part 6b of the operation panel 6. Moreover, "light ON" during visible light emission step (bright phrase), and "light OFF" during non-emission step (dark phase), for example, may be displayed on the display part 6b. Further, a display of an image of natural light during one day indicating the light inside the refrigerator (inside vegetable compartment 500) may be displayed on the display part 6b.

Specifically, for example, displays such as "day" during emission step and "night" during non-emission step may be displayed on the display part 6b, according to the step being performed by light emission control. With this configuration, the user can be notified of the state of light inside the refrigerator, so that convenience, satisfaction can be improved. In addition, the user can be warned not to needlessly open and close the door during non-emission step.

[0078]

Note that the operation panel 6 is not limited to installation on the outside of the refrigerator 1, but may be installed inside the refrigerator (inside storage compartment). Additionally, communication means may be provided in the refrigerator 1, and a mobile information terminal (mobile telephones including a smartphone, a tablet terminal, and the like) may be used to give an instruction to the controller 8 of the refrigerator 1 or receive and display information on the refrigerator 1, through an electric communication line or the like. That is, a mobile information terminal may include one or both of the functions of the operation part 6a and the display part 6b of the operation panel 6.

[0079]

The refrigerator configured in the above manner includes the vegetable compartment 500 which is a storage compartment for storing food, and the light-emitting part 14 that can emit visible light into the storage compartment. The light-emitting part 14 includes the first light source 16a that emits light having the first wavelength of a visible light region as the center wavelength, and the second light source 16b that emits light having the second wavelength of the visible light region shorter than the first wavelength as the center wavelength. The light-emitting part 14 emits light with the first radiant intensity from the first light source 16a, and simultaneously emits light with

the second radiant intensity different from the first radiant intensity from the second light source 16b, in the emission step of emitting light.

[0080]

In the embodiment, in particular, the second radiant intensity is lower than the first radiant intensity, and specifically, the ratio of the first radiant intensity to the second radiant intensity is 2:1. Hence, a certain degree of photosynthesis can be caused with less light-emitting energy amount, light-emitting energy can be used efficiently without consuming extra energy, to prompt photosynthesis of green goods of stored vegetables (particularly leaf vegetables), prompt generation of nutrients, and improve shelf stability.

[0081]

Embodiment 2

Figs. 14 to 17 relate to Embodiment 2 of the invention, where Fig. 14 is a diagram showing a configuration of a light-emitting part included in a refrigerator, Fig. 15 is a time chart of light emission control of each light source included in the light-emitting part of the refrigerator, Fig. 16 is a flowchart showing a flow of light emission control of the refrigerator, Fig. 17 is a diagram showing an example of comparison of the amounts of vitamin C when a cabbage is stored for three days under multiple light emission conditions.

[0082]

In Embodiment 2 described herein, a third light source 16c is provided in a light-emitting part 14, in addition to the aforementioned configuration of Embodiment 1. Additionally, emission step includes two steps which are: a first emission step of turning on all of a first light source 16a to the third light source 16c in emission step; and a

second emission step of turning off the third light source 16c and turning on only the first light source 16a and a second light source 16b.

[0083]

Hereinafter, a refrigerator of Embodiment 2 will be described by mainly focusing on differences from Embodiment 1.

Specifically, as shown in Fig. 14, the light-emitting part 14 further includes the third light source 16c, in addition to the first light source 16a and the second light source 16b. The third light source 16c is a visible light source, as in the case of the first light source 16a and the second light source 16b. The three types of light sources can each be turned on and off independently.

[0084]

The third light source 16c emits light having a third wavelength as the center wavelength. The third wavelength belongs to a visible light region. The third wavelength is different from any of the first wavelength or the second wavelength. In the embodiment, the third wavelength is shorter than the second wavelength (therefore, is shorter than the first wavelength, as a matter of course). To be specific, the third wavelength which is the center wavelength of the third light source 16c is not shorter than 400 nm and not longer than 500 nm. That is, the light emitted from the third light source 16c is blue. Specifically, a blue LED may be used as the third light source 16c, for example.

[0085]

The third light source 16c emits light with a third radiant intensity. The third radiant intensity is an intensity different from any of the first radiant intensity or the second radiant intensity. In the embodiment, the third radiant intensity is lower than

both of the first radiant intensity and the second radiant intensity. To be specific, the ratio of the first radiant intensity to the third radiant intensity is 5:1. The ratio of the first radiant intensity to the second radiant intensity is 2:1, as in the case of Embodiment 1. Accordingly, the ratio of the first radiant intensity to the second radiant intensity to the third radiant intensity is 10:5:2.

[0086]

The light quantity and number of each of the elements that forms the first light source 16a, the second light source 16b, and the third light source 16c provided in the light-emitting part 14 are selected, such that the radiant intensity of the first light source 16a to the third light source 16c satisfy the above relationship. Specifically, in the embodiment, two elements are provided to form the first light source 16a, and one each of elements is provided to form the second light source 16b and the third light source 16c in the light-emitting part 14.

[0087]

Next, light emission operation control of the light-emitting part 14 by a controller 8 will be described with reference to Fig. 15. The controller 8 controls operation of the light-emitting part 14 to alternately repeat emission step of causing the light-emitting part 14 to emit light including visible light, and non-emission step of not causing the light-emission part 14 to emit light including visible light. In emission step, at least one of the first light source 16a, the second light source 16b, and the third light source 16c is turned on. In non-emission step, none of the first light source 16a, the second light source 16b, and the third light source 16c is turned on.

[0088]

Emission step is further divided into two steps. In emission step, first, a first emission step is performed, and then a second emission step is performed. That is, in emission step, the controller 8 controls the light-emitting part 14, so that first emission step and second emission step are performed. In first emission step, the controller 8 causes all of the first light source 16a, the second light source 16b, and the third light source 16c to emit light. That is, red light, green light, and blue light are emitted. In second emission step, the controller 8 causes the first light source 16a and the second light source 16b to emit light, and third light source 16c is turned off. That is, red light and green light are emitted, and blue light is not emitted.

[0089]

The duration of each step is set in advance. In this connection, the duration of first emission step is defined as $\Delta T1$, the duration of second emission step is defined as $\Delta T2$, and the duration of non-emission step is defined as $\Delta T3$.

[0090]

Thus, the controller 8 controls the light-emitting part 14, so that first emission step, second emission step, and non-emission step are performed in this order. Then, after completion of non-emission step, the steps are repeated again from visible light emission step, that is, first emission step, in the aforementioned order. Accordingly, a time ΔT taken for one cycle in which once of each step is performed in sequence is the total of $\Delta T1$, $\Delta T2$, and $\Delta T3$. The duration of visible light emission step is the total of $\Delta T1$ and $\Delta T2$.

[0091]

The controller 8 controls the light-emitting part 14, so that visible light emission step and non-emission step are repeated alternately in a 24 hour or shorter cycle. That

is, ΔT is set to 24 hours or shorter. Additionally, the duration $\Delta T3$ of non-emission step is set to be not longer than the duration of visible light emission step. In other words, the duration $\Delta T3$ of non-emission step is set to be not longer than the total time of the duration $\Delta T1$ of first emission step and the duration $\Delta T2$ of second emission step. Specifically, as an example of duration of the steps satisfying the above condition, $\Delta T1$ is set to 2 hours, $\Delta T2$ is set to 10 hours, and $\Delta T3$ is set to 12 hours. In this case, ΔT is 24 hours.

[0092]

A sequential flow according to control of the light-emitting part 14 of a vegetable compartment 500 included in a refrigerator 1 configured in the above manner will be described with reference to the flowchart of Fig. 16. When the refrigerator 1 is powered on, first, in step S201, the controller 8 turns on the first light source 16a, the second light source 16b, and the third light source 16c of the light-emitting part 14. In next step S202, the controller 8 resets the value of a timer t measuring elapsed time to zero, and starts measuring by the timer.

[0093]

Then, in next step S203, the controller 8 checks whether the elapsed time t of the timer has reached $\Delta T1$. If the elapsed time t of the timer has not reached $\Delta T1$, the checking in step S203 is repeated until the elapsed time t of the timer reaches $\Delta T1$. Thereafter, when the elapsed time t of the timer reaches $\Delta T1$, the processing proceeds to step S204. Steps S201 to S203 described above form first emission step.

[0094]

In step S204, the controller 8 turns off the third light source 16c of the light-emitting part 14. Hence, only the first light source 16a and the second light source 16b

are turned on. In next step S205, the controller 8 resets the value of the timer t measuring elapsed time to zero, and starts measuring by the timer.

[0095]

Then, in next step S206, the controller 8 checks whether the elapsed time t of the timer has reached $\Delta T2$. If the elapsed time t of the timer has not reached $\Delta T2$, the checking in step S206 is repeated until the elapsed time t of the timer reaches $\Delta T2$. Thereafter, when the elapsed time t of the timer reaches $\Delta T2$, the processing proceeds to step S207. Steps S204 to S206 described above form second emission step.

[0096]

In step S207, the controller 8 turns off the first light source 16a and the second light source 16b of the light-emitting part 14. Hence, all of the first light source 16a, the second light source 16b, and the third light source 16c are turned off. Then, the processing proceeds to step S208, and the controller 8 resets the value of the timer t measuring elapsed time to zero to start measuring by the timer.

[0097]

In next step S209, the controller 8 checks whether the elapsed time t of the timer has reached $\Delta T3$. If the elapsed time t of the timer has not reached $\Delta T3$, the checking in step S209 is repeated until the elapsed time t of the timer reaches $\Delta T3$. Thereafter, when the elapsed time t of the timer reaches $\Delta T3$, the processing returns to step S201, and the above steps are repeated. Steps S207 to S209 described above form non-emission step.

Note that other configurations and operations are the same as Embodiment 1, and detailed descriptions will be omitted.

[0098]

Next, expected effects of the above-mentioned light emission in the light-emitting part 14 will be described. First, in Embodiment 2 of the invention, the first light source 16a emits red light with the first radiant intensity. In addition, the second light source 16b emits green light with the second radiant intensity. Then, the third light source 16c emits blue light with the third radiant intensity. In the embodiment, the third radiant intensity is lower than the first and second radiant intensity, and specifically, the ratio of the first to second to third radiant intensity is set to 10:5:2.

[0099]

Then, in emission step of emitting light, the light-emitting part 14 emits light from the first light source 16a with the first radiant intensity, simultaneously emits light from the second light source 16b with the second radiant intensity, and also simultaneously emits light from the third light source 16c with the third radiant intensity. As has been described in Embodiment 1, the longer the wavelength of the emitted light, the larger the number of photons included in the light. Accordingly, a larger photon flux density can be obtained from an even smaller total light-emission energy, whereby photosynthesis of the vegetables irradiated with light can be prompted efficiently.

[0100]

As also mentioned earlier, the absorption spectrum of chlorophyll has a blue (around 450 nm) light absorption peak in addition to red (around 660 nm), and this wavelength is particularly effective for photosynthesis. Moreover, blue light has an effect of opening pores of plant. Accordingly, by emitting light including blue in the initial stage of a bright phase of emitting light, pores of green goods can be opened. Then, by continuing the bright phase after opening the pores of the green goods, the green goods can take in a sufficient amount of carbon dioxide in the air, and can perform

photosynthesis efficiently. On the other hand, blue light also has an effect of prompting sprouting and flowering. For this reason, when long-term storage of green goods is desired, emission of blue light should be kept as short as possible.

[0101]

In view of the foregoing, in visible light emission step of prompting photosynthesis, firstly, the third light source 16c is turned on in first emission step to emit light including blue light, and then the third light source 16c is turned off in second emission step to emit light that does not include blue light. Thus, photosynthesis can be performed after opening pores of green goods inside the lower storage case 10, so that photosynthesis of the green goods inside the lower storage case 10 can be prompted even more. Also, at this time, by setting first emission step of emitting light including blue light shorter than second emission step of emitting light not including blue light, sprouting and flowering can be avoided, while achieving a sufficient pore opening effect.

[0102]

Hereinafter, referring to Fig. 17, a description will be given by use of specific comparative examples, of what difference occurs in the amount of nutrient (vitamin C) included in green goods, when the green goods are stored under multiple different light emission conditions as described above. Fig. 17 is a graph comparing the amounts of vitamin C after storing a cabbage for three days under multiple different light emission conditions. The way of expressing the amount of vitamin C, the light emission conditions, and the result of "No emission" are the same as Fig. 12, and therefore descriptions are omitted.

[0103]

When a bright phase during which light is omitted and a dark phrase during which light is not emitted were provided and light emission was performed according to the circadian rhythm, the vitamin C after storage increased. Then, as compared to a case where red light and green light were emitted during a 12 hour bright phase (center graph in Fig. 17), the amount of vitamin C after storage increased even more, when blue light is further emitted during two hours at the beginning of the 12 hour bright phase (right graph in Fig. 17).

[0104]

The refrigerator configured in the above manner not only can achieve the same effects as Embodiment 1, but can also avoid prompting sprouting and flowering, while achieving a sufficient pore opening effect. Hence, vegetables can be stored in high quality by prompting generation of nutrients by photosynthesis, and suppressing undesired transpiration.

[0105]

Embodiment 3

Fig. 18 relates to Embodiment 3 of the invention, and is a diagram showing a configuration of a light-emitting part included in a refrigerator.

In Embodiment 3 described herein, a second radiant intensity, that is, the radiant intensity of green light, is set higher than a first radiant intensity, that is, the radiant intensity of red light, in the aforementioned configuration of Embodiment 1 or Embodiment 2.

[0106]

Hereinafter, the refrigerator of Embodiment 3 will be described on the basis of the configuration of Embodiment 2, by mainly focusing on differences from Embodiment 2.

Specifically, as shown in Fig. 18, a light-emitting part 14 includes a first light source 16a, a second light source 16b, and a third light source 16c. The three types of light sources are all visible light sources, and can each be turned on and off independently.

[0107]

The first light source 16a, the second light source 16b, and the third light source 16c emit light respectively having a first wavelength, a second wavelength, and a third wavelength as the center wavelength. To be specific, the first wavelength is not shorter than 500 nm and not longer than 700 nm (preferably not shorter than 600 nm and not longer than 700 nm), the second wavelength is not shorter than 500 nm and not longer than 560 nm, and the third wavelength is not shorter than 400 nm and not longer than 500 nm. Accordingly, the light emitted from the first light source 16a is red, the light emitted from the second light source 16b is green, and the light emitted from the third light source 16c is blue.

[0108]

The first light source 16a, the second light source 16b, and the third light source 16c respectively emit light with a first radiant intensity, a second radiant intensity, and a third radiant intensity. In the embodiment, unlike Embodiments 1 and 2, the second radiant intensity is higher than the first radiant intensity. Specifically, for example, the ratio of the first radiant intensity to the second radiant intensity is 5:6. The fact that the third radiant intensity is lower than both of the first radiant intensity and the second radiant intensity is the same as in Embodiment 2. To be specific, the ratio of the first radiant intensity to the third radiant intensity is 5:1, as in the case of Embodiment 2.

Accordingly, the ratio of the first radiant intensity to the second radiant intensity to the third radiant intensity is 5:6:1.

[0109]

The light quantity and number of each of the elements that forms the first light source 16a, the second light source 16b, and the third light source 16c provided in the light-emitting part 14 are selected, such that the radiant intensity of the first light source 16a to the third light source 16c satisfy the above relationship. Specifically, in the embodiment, two elements are provided to form the second light source 16b, and one each of elements is provided to form the first light source 16a and the third light source 16c in the light-emitting part 14.

[0110]

In light emission step, the light-emitting part 14 emits light from the first light source 16a with the first radiant intensity, simultaneously emits light from the second light source 16b with the second radiant intensity, and also simultaneously emits light from the third light source 16c with the third radiant intensity.

Note that other configurations and operations are the same as Embodiment 1 or 2, and detailed descriptions will be omitted.

[0111]

In the embodiment, the first light source 16a, the second light source 16b, and the third light source 16c are configured to emit light having high intensity. In this case, in the green goods (vegetables) irradiated with light, light saturation tends to occur in photosynthesis on chlorophyll on the front side of leaves, while light saturation does not occur on chlorophyll on the inside and rear side. In this state, if the light-emission energy of the first light source 16a (red) is increased, red has a relatively high absorption

rate on leaves, and therefore is absorbed on chlorophyll on the front side. However, since light saturation occurs in photosynthesis on the front side of leaves, most of the red light energy is dissipated as heat.

[0112]

Meanwhile, the second light source 16b (green LED) has relatively low absorption rate of leaves, and therefore can activate chlorophyll on the inside and rear side of leaves where light saturation has not occurred, and prompt photosynthesis. In view of this, by setting the second radiant intensity higher than the first radiant intensity, that is, by setting the light-emission energy of the second light source 16b (green) higher, photosynthesis can be performed efficiently without wasting light-emission energy from the light source.

[0113]

The refrigerator configured in the above manner, too includes the vegetable compartment 500 which is a storage compartment, and the light-emitting part 14 that can emit visible light into the storage compartment. The light-emitting part 14 includes the first light source 16a that emits light having the first wavelength of a visible light region as the center wavelength, and the second light source 16b that emits light having the second wavelength of the visible light region shorter than the first wavelength as the center wavelength. The light-emitting part 14 emits light with the first radiant intensity from the first light source 16a, and simultaneously emits light with the second radiant intensity different from the first radiant intensity from the second light source 16b, in the emission step of emitting light.

[0114]

Here, in particular, the second radiant intensity is higher than the first radiant intensity, and specifically, the ratio of the first radiant intensity to the second radiant intensity is 5:6. For this reason, wasteful light-emitting energy amount converted into heat can be suppressed, and light-emitting energy can be used sufficiently without consuming extra energy. Thus, photosynthesis of stored green goods such as vegetables (particularly leaf vegetables) can be prompted, generation of nutrients can be prompted, and shelf stability can be improved.

Industrial Applicability

[0115]

The invention can be used in a refrigerator that includes a light-emitting part in a storage compartment for storing food, and in which visible light is emitted from the light-emitting part into the storage compartment.

Reference Signs List

[0116]

- 1 Refrigerator
- 2 Compressor
- 3 Cooler
- 4 Blower fan
- 5 Air channel
- 6 Operation panel
- 7 Cold room door
- 7a Right door

- 7b Left door
- 8 Controller
 - 8a Processor (CPU)
 - 8b Memory
- 9 Vegetable compartment door
- 10 Lower storage case
- 11 Upper storage case
- 12 Door opening and closing detection switch
- 13 Thermistor
- 14 Light-emitting part
- 15 Opening
 - 16a First light source
 - 16b Second light source
 - 16c Third light source
- 90 Thermal insulation case
- 100 Cold room
 - 200 Switchable room
 - 300 Ice making room
 - 400 Freezer room
 - 500 Vegetable compartment
- 201 Switchable room storage case
- 401 Freezer room storage case

Claims

[Claim 1]

A refrigerator comprising:

a storage compartment configured to store food; and

a light-emitting part configured to be able to emit visible light to an inside of the storage compartment,

the light-emitting part including:

a first light source configured to emit light having a first wavelength of a visible light region as a center wavelength; and

a second light source configured to emit light having a second wavelength of the visible light region shorter than the first wavelength as the center wavelength,

the light-emitting part configured to emit, in an emission step of emitting light, light with a first radiant intensity from the first light source, and simultaneously, light with a second radiant intensity different from the first radiant intensity from the second light source.

[Claim 2]

The refrigerator according to claim 1, wherein the first wavelength is not shorter than 600 nm and not longer than 700 nm.

[Claim 3]

The refrigerator according to claim 1 or 2, wherein the second wavelength is not shorter than 500 nm and not longer than 560 nm.

[Claim 4]

The refrigerator according to any one of claims 1 to 3, wherein the second radiant intensity is lower than the first radiant intensity.

[Claim 5]

The refrigerator according to claim 4, wherein a ratio of the first radiant intensity to the second radiant intensity is 2:1.

[Claim 6]

The refrigerator according to any one of claims 1 to 3, wherein the second radiant intensity is higher than the first radiant intensity.

[Claim 7]

The refrigerator according to claim 6, wherein a ratio of the first radiant intensity to the second radiant intensity is 5:6.

[Claim 8]

The refrigerator according to any one of claims 1 to 7, wherein:

the light-emitting part further includes a third light source configured to emit light having a third wavelength of the visible light region shorter than the second wavelength as the center wavelength; and

the light-emitting part is configured to emit, in the emission step, light with the first radiant intensity from the first light source, simultaneously, light with the second radiant intensity from the second light source, and simultaneously, light with a third radiant intensity lower than both of the first radiant intensity and the second radiant intensity from the third light source.

[Claim 9]

The refrigerator according to claim 8, wherein the third wavelength is not shorter than 400 nm and not longer than 500 nm.

[Claim 10]

The refrigerator according to claim 8 or 9, wherein a ratio of the first radiant intensity to the third radiant intensity is 5:1.

[Claim 11]

The refrigerator according to any one of claims 1 to 10, wherein the light-emitting part is configured to alternately repeat the emission step and a non-emission step of not emitting light.

[Claim 12]

The refrigerator according to claim 11, wherein the light-emitting part is configured to alternately repeat the emission step and the non-emission step in a 24 hour or shorter cycle.

[Claim 13]

The refrigerator according to claim 11 or 12 further comprising a door configured to be able to open and close the storage compartment, and

detection means configured to detect opening and closing of the door, wherein the light-emitting part is configured to perform the non-emission step at a time when a number of times of opening and closing of the door per preset reference time detected by the detection means is not larger than a preset number of times.