

REFRIGERATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a technique preserving food such as vegetables in a refrigerator.

2. Description of the Related Art

Conventional refrigerators have improved a preserving technique which keeps freshness of vegetables by
10 irradiating vegetable with the light from a red LED from an upper portion (see, for example, JP-A-2002-267348). Further, by providing a white fluorescent lamp and controlling turning on thereof by a switch for detecting the opening and closing of a door, chlorophyll decline of
15 green vegetables has been reduced (see, for example, JP-A-9-28363). Further, a study on a respiration action or a low temperature obstacle caused by LED irradiation at a non-freezing temperature of food at 0°C or below has been made (see, for example, JP-A-2001-61459).

20 Conventional refrigerators have the following problems.

First, when using a red LED, the appearance of the vegetables does not look appealing. Second, when the turning on time is controlled by detecting the opening and
25 closing of a door, detector means for detecting the opening

and closing of a door is required. Third, when irradiating light from an upper portion, it is impossible to irradiate food within a receiving container located at a lower portion. Fourth, when irradiating light from an upper portion, it is difficult to wire electric parts. Fifth, if light is irradiated from an upper portion or only when a door is closed, it is difficult to confirm whether the light is functioning at home or the store. In a case of a household refrigerator, various kinds of vegetables or other kinds of food in addition to vegetables are preserved and located in an empty place, overlapped or interlaid without specifically determining a preservation place in various preservation forms such as space, period, or state. Further, they may be preserved by a method of dividing into refrigeration and freeze regardless of temperature. Light irradiation has a preservation effect in all preservation forms of a refrigerator and the refrigerator required for food preservation is that have no negative effect, low power consumption, and high efficiency, and in addition the refrigerator parts having long life span and low maintenance is requested. However, when the refrigerator employs white fluorescent light, it has both a good and a negative effect and even though it is tested using a red or blue lamp having wavelength convenient for certain preservation effect, a practical refrigerator cannot be

obtained because it still has inconvenient preservation conditions.

SUMMARY OF THE INVENTION

5 The present invention is contrived in view of the above-mentioned situation. It is an object of the present invention to provide a refrigerator for allowing food such as vegetables to have an appeasing appearance and effectively preserving food in various kinds of
10 preservation forms.

It is another object of the present invention to provide a refrigerator having a long life span and high efficiency by effectively using small semiconductor light-emitting elements (LED).

15 It is another object of the present invention to provide a refrigerator having preservation property because light can be irradiated even to food preserved in a necessary place such as the interior of a receiving container in a lower portion.

20 It is an additional object of the present invention to provide a refrigerator which can easily maintain LEDs, and be assembled at low cost, use energy efficiently, and is easy to recycle.

It is yet another object of a refrigerator which
25 improves the food preservation property by using natural

light having no negative effect to food which is used as a light within the refrigerator as well as for food preservation.

In order to achieve the above-mentioned objects, the refrigerator according to the present invention includes a plurality of light sources which irradiates light with a wavelength giving warmth and a control device which individually controls turning on of the plurality of light sources. Further, it has a receiving container for receiving food which has places where light from light sources are irradiated or not irradiated.

According to the refrigerator of the present invention, it is possible to increase the nutritive substance without damaging the appearance of food such as vegetables, and use light source as a lamp within the refrigerator because the light source irradiate light with a wavelength giving warmth. Further, since the light sources according to the refrigerator of the present invention intermittently irradiate LEDs, alternately controls they are turned on by the respective LEDs, and thus increases the life span of the LEDs, it is possible to obtain a refrigerator having high efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of this

invention will become more fully apparent from the following detailed description taken with the accompanying drawings in which:

Fig. 1 is a cross-sectional view illustrating a refrigerator according to a first embodiment of the present invention;

Fig. 2 is a perspective view illustrating a vegetable chamber according to the first embodiment of the present invention;

Fig. 3 is a graph illustrating wavelength distribution of a light irradiation device according to the first embodiment of the present invention;

Fig. 4 is a perspective view illustrating the light irradiation device according to the first embodiment of the present invention;

Fig. 5 shows a table illustrating the relationship between color and LED wavelength of the light irradiation device according to the first embodiment of the present invention;

Fig. 6 is a graph illustrating wavelength characteristics of a photoreaction operation in plant according to the first embodiment of the present invention;

Fig. 7 is a circuit diagram illustrating the light irradiation device according to the first embodiment of the present invention;

Fig. 8 is a diagram illustrating the light irradiation device mounting to a substrate according to the first embodiment of the present invention;

Fig. 9 is a flowchart illustrating the control of
5 light irradiation according to the first embodiment of the present invention;

Fig. 10 is a time chart illustrating the control of light irradiation according to the first embodiment of the present invention;

10 Fig. 11 is a block diagram illustrating the result of a vegetable test according to the first embodiment of the present invention.

Fig. 12 is a perspective view illustrating another vegetable chamber according to the first embodiment of the
15 present invention;

Fig. 13 is a cross-sectional view illustrating other refrigerator according to the first embodiment of the present invention;

Fig. 14 is a cross-sectional view illustrating other
20 refrigerator according to the first embodiment of the present invention;

Fig. 15 is a cross-sectional view illustrating other refrigerator according to the first embodiment of the present invention;

25 Fig. 16 is a perspective view illustrating the

interior of another vegetable chamber according to the first embodiment of the present invention;

Fig. 17 is a perspective view illustrating other refrigerator according to the first embodiment of the present invention;

Fig. 18 is a cross-sectional view illustrating another vegetable chamber according to the first embodiment of the present invention;

Fig. 19 is a cross-sectional view illustrating other light irradiation device according to the first embodiment of the present invention;

Fig. 20 is a circuit diagram illustrating the light irradiation device according to the first embodiment of the present invention;

Fig. 21 is a diagram illustrating the rate of electric current according to the first embodiment of the present invention;

Fig. 22 is a diagram illustrating a modified example of the rate of electric current according to the first embodiment of the present invention; and

Fig. 23 is a flowchart illustrating a modified example of the rate of electric current according to the first embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

Fig. 1 is a cross-sectional view illustrating a refrigerator according to a first embodiment of the present invention. Fig. 2 is a perspective view illustrating the outline of a vegetable chamber according to the first embodiment. Fig. 3 is a graph illustrating wavelength characteristics of an LED that is a semiconductor light-emitting element. Fig. 4 is an enlarged cross-sectional view illustrating a light irradiation device.

As shown in Fig. 1, a refrigerator body denoted by reference numeral 1 includes a refrigerating chamber 100 with an opening and closing door located in an uppermost portion of the refrigerator 1, a switching chamber 400 with a drawer-type door which is located under the refrigerating chamber 100 and which can be switched to temperature zones for cold storage, vegetable storage, chilling, soft freezing (-7°C), etc. from a freezing temperature zone (-18°C), an ice chamber 500 with a drawer-type door which is located in parallel with the switching chamber, and a vegetable chamber 300 with a drawer-type door which is located between a freezing chamber 200 disposed in a lowermost portion, and the switching chamber or the ice chamber. An operation panel

5 composed of an operation switch for controlling setting values such as temperature of the respective chambers, liquid crystal for displaying temperature of the respective chambers at that time, etc. are provided on the
5 door of the refrigerating chamber 100. As shown in Figs. 1 and 2, a receiving container 30 made of a material having no light transmissibility and a second receiving container 31 made of a material having light transmissibility provided in an upper portion thereof are
10 provided in the vegetable chamber 300 so that food such as vegetable can be received therein. White plastics or metals such as stainless steel or alumina are used as a material having no light transmissibility. As shown in Fig. 2, a light irradiation device denoted by reference
15 numeral 32 is provided on the back side of the second receiving container so that it irradiates light around a central portion of the second receiving container. The light irradiation device 32 has its peak at 590 nm as shown in Fig. 3 and is composed of a substrate to which
20 four LEDs 34 that emit light with wavelengths ranging from 550 to 620 nm are mounted.

As shown in Fig. 1, reference numeral 10 represents a compressor, reference numeral 11 represents a cooler, reference numeral 12 represents a fan for sending cold air
25 cooled by the cooler to the refrigerating chamber 100 and

the freezing chamber 200, reference numeral 13 represents a damper device for controlling an amount of cold air sent into the refrigerating chamber 100, and reference numeral 14 represents an air duct for introducing cold air cooled
5 by the cooler 11 into the refrigerating chamber 100. The substrate 22 of the control device for controlling the turning on or turning off of the light irradiation device 32 is received in an electric part chamber 21 located on the backside of the refrigerator and controlled by a micro
10 computer or the like which is also received in the substrate.

As shown in Fig. 4, the light irradiation device 32 is composed of a mounting substrate 33, semiconductor light-emitting element LEDs 34, which are the light sources,
15 provided parallel on the mounting substrate 33, and a light transmitting cover 35 for protecting the LEDs 34. Because the directivity of LED tends to be narrow by the degree of high brightness, the mounting substrate 33 and the cover 35 are fixed by screws so that the irradiation angle is not
20 changed by the vibration of the refrigerator. The back surface of the mounting substrate 33 is coated by a seal 36 to prevent circuit from being shorted. Further, the light irradiation device 32 is built in front of an insulating portion 37 located on the backside of the vegetable chamber
25 300 so that light from the LEDs 34 is irradiated into the

vegetable chamber 300. Here, by fitting an O-ring 38 so as to prevent dew from attaching on the cover 35, the degree of close contact is increased and thus cold air is intercepted, and dew is prevented from attaching to the mounting substrate 33 or light is prevented from being irregularly reflected due to water drops. Further, because the cover 35 has protrusions 39, the receiving container is prevented from striking on the cover surface, so the light is prevented from being irregularly reflected if damage occurs to cover surface. Therefore, the mounting substrate 33 and the LEDs 34 are prevented from being damaged or broken down. In order to protect the cover surface from collision, the protrusion 39 is provided considering various situations such as handling for the cover 35 during manufacturing and detachment of the receiving container when using.

Further, because the light irradiation device is provided on the back side, specifically the back surface of the refrigerator where the vegetable chamber is located, access to fan, damper, or other electric parts is easy, so that it is easy to wire and it is possible to manufacture at low cost. Further, when cold air is circulated through the refrigerator, an entry or an exit hole is provided on the backside of the refrigerator and thus the direction to irradiate light from the back side to the front side of the

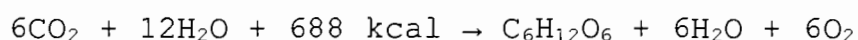
refrigerator is the same as moving cold air, that is, the direction of moving forward or back cold air. Food storage compartments of the refrigerator such as the refrigerating chamber that has no receiving container or the vegetable
5 chamber that has a receiving container have a structure that easily passes cold air, and irradiation of light is also because of the following the same direction as the cold air. Further, since the illumination device of the refrigerator is provided on the backside of refrigerator,
10 it is easy to see the inside of the refrigerator when opening the door thereof.

Further, when the illumination device is provided on the backside of the refrigerator, it is easier for a user to confirm the turning on state rather than when provided
15 in the upper side or the side surface, it is possible to easily appeal goods in a store or confirm a turning on state at home. Further, the structure of the insulation materials on the backside of the refrigerator is relatively stronger than that of partitions divided into the
20 refrigerator chambers and vibration applied to LEDs is minimal, thereby giving reliability.

Fig. 5 shows the absorption wavelengths of visible rays and their colors. FIG. 6 shows an effect of plant growth in unit energy for the respective wavelengths. The
25 LED 34 emits light with wavelengths of visible ray area and

the visible rays ranges from the violet, which is the shortest wavelength shown in Fig. 5, blue, green, yellow, and orange, to the red, which is the longest wavelength. Further, plants basically grow by photosynthesis and uses nutritious substance stored in the photosynthesis as an energy source when performing photomorphogenesis which is required for the qualitative change in plants such as seed germination, flower bud differentiation, blooming, expansion of seed leaf, chlorophyll synthesis, root and trunk extension change. As shown in Fig. 6, photomorphogenesis which is not proper for vegetable preservation such as germination or blooming among them is tended to be promoted by the blue light around 470 nm and the red light component around 660 nm. Further, the absorption peak of chlorophyll is highest at blue and red light components and lowest at green and yellow light components. On the other hand, as shown in Fig. 6, the energy efficiency of photosynthesis is low at red light component that is the highest short wavelength. However, in visible ray area, the first effective color is the red and the second effective color is the blue for the photosynthesis speed and the other colors are effective at long wavelengths. However, wavelengths around blue light promote germination or blooming and thus are improper for long-term preservation of vegetables.

Next, photosynthesis reaction is given by the following equation.



(CO₂: carbon dioxide, H₂O: water, 688 kcal: light
5 energy. C₆H₁₂O₆: glucose)

The reaction is divided into a light reaction using light energy and a dark reaction using no light energy. The light reaction is a reaction which converts light energy from the sun into chemical energy. Carbon dioxide is not
10 used during this step and pigment such as chlorophyll decomposes water into hydrogen and oxygen using light energy and chemical energy is stored by the function of enzyme protein. On the other hand, in the dark reaction, glucose is composed using hydrogen generated in light
15 reaction and carbon dioxide from the air. Further, vegetables having increased glucose have improved storage property or creates vitamin C from glucose.

As can be seen from above, an exothermic reaction is restrained by using a plurality of LEDs and thus
20 transpiration of vegetable and so on, that is, it is possible to effectively promote photosynthesis by using the red LED as the LED 34. Nevertheless, the red light component makes the vegetables unappealing and the deterioration of vegetable visually seen and gives an image
25 of warning, therefore improper for turning on of the

refrigerator. A color friendly LED can be obtained when near a glow lamp by using a color giving warmth such as a yellow light component with a wavelength of about 590 nm or an orange light component with a wavelength of about 600 nm, which is not a red light component that gives an unappealing effect, thereby achieving both the photosynthesis effect and illumination effect. Further, as shown in Fig. 6, it is possible to obtain food preservation effect of photosynthesis. As shown in Fig. 5, color giving warmth can be obtained by using light having a peak value in a range of 580 to 610 nm, that is, a wavelength range from a yellow light component to an orange light component.

Further, light irradiation devices using a plurality of LEDs which combines the red LED and the blue LED irradiate light which is set to the absorption peak of chlorophyll and effectively improves performance of photosynthesis. That is, it is possible to obtain color giving warmth by simultaneously emitting a plurality of colors and obtain individual results by individually emitting light. Further, it is possible to combine monochromatic emitting LEDs and combine fluorescent substance, and LED.

Further, when the number of LEDs having high brightness or diffusion type LEDs is reduced, it is possible to obtain the light irradiation device 32 that has

the photosynthesis and illumination results at low cost.

Further, Fig. 7 shows an electric circuit diagram of the light irradiation devices, and Fig. 8 is a diagram showing mounting arrangement of LEDs 34, where a system 34A in which LEDs 34a and 34b of two mounting substrates are arranged parallel and a system 34B in which LEDs 34c and 34d of two mounting substrates are arranged parallel are arranged parallel. LEDs 34a, 34b, 34c, and 34d are emitted by making DC 5 V to 12 V to be applied and current of about 30 mA to flow. A current value of about 30 mA is small and safe. Further, when two LEDs compose one system as in 34A and 34B, as shown in Fig. 8, each system is arranged in vertical and a microcomputer controls the turning on and turning off of each system, and illuminance of about 100 Lx within the irradiation range is secured when only one system is turned on but illuminance of about 300 Lx is secured when two systems are turned on and thus the LED life is increased. Hence, it is possible to secure enough life without having to detect the opening and closing of the door. Further, by controlling a plurality of LEDs as a system, the board number of the microcomputer can be reduced and thus it is possible to simplify the substrate. As shown in Fig. 7, turning on and turning off of the LEDs is controlled by using a transistor for turning on or off by a signal output from the microcomputer and a resistance

for limiting current by setting the current flow to the LEDs in series to the LEDs. In a practical mounting substrate, if the resistance is arranged in the control substrate, the mounting substrate 33 of the light irradiation device 32 can be minimized and thus it can be easily arranged in the vegetable chamber and the resistance can be restrained from heating and thus preservation performance of vegetable prevented is enhanced. On the other hand, if the resistance is arranged in the mounting substrate of the light irradiation device 32, it is possible to easily confirm turning on or a defective error at failure and so on. Further, the control of turning on and turning off is explained in two and four combination lines but it may be performed in 8 or 12 combination lines using at least one. Further, applied voltage and current can properly be selected depending on the number of LEDs to use or necessary illumination.

In order to make vegetable have abundant nutritive substance with increased vitamin C by promoting synthesis of glucose and so on in preserved vegetables and enhancing storage property, it is necessary to limit turning on of four LEDs, and limit turning on period or illumination from dark reaction of photosynthesis. By such limitation, the LED life is increased, so that it is unnecessary to exchange the light irradiation devices. Thereby, it is

possible to effectively preserve food without using wasting energy.

Hereinafter, the operation of a refrigerator having the above-mentioned composition will be described.

5 Cold air cooled by the cooler 11 shown in Fig. 1 is transferred to the freezing chamber 200 by a fan 12 and the freezing chamber is cooled to about -18°C , that is, a predetermined temperature. On the other hand, a part of the cold air cooled by the cooler 11 passes through the air
10 duct 14, is controlled by the opening and closing of a damper 13, and is transferred to the refrigerating chamber 100, the switching chamber 400, and the ice chamber 500, and the refrigerating chamber 100 is cooled to a predetermined temperature of about 3°C . The switching
15 chamber 400 is cooled to the preset temperature, and the ice chamber 500 is cooled to -18°C . Because the vegetable chamber 300 restrains vegetables from performing transpiration, it is indirectly cooled to a predetermined temperature of about 5°C using radiation from the switching
20 chamber 400 and the ice chamber 500 in the upper portion of the vegetable chamber 300 and the freezing chamber 200 in the lower portion of the vegetable chamber 300 without direct blowing of cold air. Further, as already described, the vegetable chamber 300 may have a structure of
25 circulating cold air instead of indirect cooling.

As shown in Fig. 2, the receiving container 30 and a second receiving container 31 are provided in the vegetable chamber 300 and when vegetables are received in the vegetable chamber, vegetables such as spinach or komatsuna, etc. having mainly photosynthesis effect are received in the second receiving container 31 and root vegetables such as potato, onion, etc. and so on which are good to preserve in dark place are received in the receiving container 30. Vegetables received in the second receiving container 31 are irradiated by the light irradiation device 32 on the backside of the second receiving container 31. Then, when the high-brightness type LED 34 is used for turning on four lamps, it can make a light irradiation place have the range from about 300 to 400 Lx and when it is used for turning on four lamps, and it can make a light irradiation place have the range from about 100 to 150 Lx. On the other hand, a material having no light transmissibility or food received in the second receiving container 31 prevent light from being irradiated to root vegetables received in the receiving container 30.

Fig. 9 is a flowchart illustrating simple control of the light irradiation devices, and Fig. 10 is a diagram illustrating the control of light irradiation and photosynthesis of vegetable. As shown in Fig. 9, according to initial data stored in a microcomputer of a control

substrate in step 40 after the refrigerator body 1 is powered on, two lamps in the LEDs 34 of the light irradiation device 32 are turned on by two-lamp turning on data in step 41 and the LEDs 34 of the light irradiation device 32 are not turned on by light turning off data in step 42.

Next, in step 43, when the refrigerator performs a defrost operation, four lamps in the LEDs 34 are turned on in step 44, the process goes to a step 46 when passing 3 hours after irradiation of four lamps in the LEDs 34 in step 45 and two lamps are turned on or turning on is turned off by data received from the control substrate. In step 46, a state before going to the defrost operation of step 43 is stored and the same state is embodied. Because the defrost operation of step 43 is controlled to perform one time on one day, series control from steps 43 to 46 are performed and thus light of 300 Lx or more is irradiated for 3 hours in one day.

As shown in Fig. 10, the defrost operation in step 43 is performed by turning on four lamps in the LEDs and vegetables irradiated by light perform light reaction of photosynthesis and two lamps are turned on or turning on is turned off after 3 hours of light reaction, whereby dark reaction is performed. The defrost operation in the refrigerator is an operation for removing water, which is

included in the cold air, adhered to a pin of the cooler 11 that is an evaporator when cold air circulates to cool the refrigerator. The evaporator in a refrigerating cycle cools air of the refrigerator in a heat exchanger when
5 refrigerant circulating in a compressor 10 vaporizes, water included in air of the refrigerator at that time is fixed to the pin of the cooler as frost. The frost is evaporated and removed by activating the heater provided in the lower portion of the cooler.

10 At this time, although the fan 12 in the refrigerator is stopped, the damper is closed, and cold air is not blown into the chambers, blowing of cold air is intercepted and heat from heater is leaked, causing temperature within the refrigerator to increase. Because photosynthesis operation
15 vigorously generates enough heat to raise the temperature of the inside of the refrigerator under the temperature of 0°C or less, it is effective to increase irradiation intensity from light source of the refrigerator in the defrost operation. Further, because the defrost operation
20 is performed at the time duration when it is the least door opening operation by storing door opening pattern of the refrigerating chamber during one day, it is good to irradiate light from light source depending on such preset condition. Further, the defrost operation in the freezing
25 chamber may be performed in cooperation with irradiation of

ultraviolet rays and illumination of the refrigerator.
Further, the defrost operation is described as a standard
for controlling light irradiation but the time duration is
set by storing the opening and closing of door or the night
5 time duration is set in advance and thus turning on may be
performed during only the time duration, and the turning on
may be turned off during the other time duration or the
time duration for raising illuminance, for example, the
night time duration or the other time duration may be set.
10 The cycle of turning on and turning off or that of
illuminance up and illuminance down is not required to be
once in one day and may be set depending on the necessity
of nourishment increase for vegetables.

Next, by operating the operation switch of the
15 operation panel 5 provided in the door of the refrigerator
100, the LED can be changed to turning on and turning off.
The operation panel receives switch input in step 49, light
indication is turned on when turning on the LED, and
turning off indication is turned off when turning off the
20 LED, and status data is sent to the control substrate. The
control standard of the signal received in step 50 makes
two lamps in the LEDs 34 to be turned on or turned off
depending on the data. The LED can be turned on or off by
the switch operation, that is, turned off can be selected
25 by the switch operation when a user seldom preserves leaf

vegetables or for the winter season when leaf vegetables are seldom preserved.

Further, the operation panel may be provided outside or inside the refrigerator. The operational instruction on
5 the illumination device of the refrigerator from the operation panel is converted into a signal by an IC adaptor provided in a residence through internet from a cellular phone and so on in residing and delivered to the control device in the refrigerator through cable such as an
10 electric line or radio.

Further, the kind of light irradiation in which a user can select are three steps: four-lamp turning on, two-lamp turning on and turning off. In addition, two steps of turning on and turning off, for example, when giving
15 importance to a photosynthesis effect, four-lamp turning on may be selected, when requesting to function only as a lamp of the refrigerator when opening the door, two-lamp turning on may be selected, and when giving importance to the energy saving, turning off may be selected. Further, when
20 three steps of four-lamp turning on, two-lamp turning on, turning off are connected to high, middle, and low temperature set of the vegetable chamber, and the high stage high has temperature environment suitable for leaf vegetables, the middle stage middle has a preservation
25 effect by turning on continuously or intermittently the

normal vegetable chamber, and the low stage has function for energy saving which does not execute authentication nor raise the temperature setting. Therefore, three stages are applied to the vegetable so it is not necessary to set special light irradiation to the operation panel and thus the operation panel interface is simplified. Further, the LEDs may be turned off by connecting to the "energy saving mode" or the "power saving mode" to be set in the operation panel.

Finally, in step 53, when power of the refrigerator 1 is reset by being unplugged or power failure and so on, the data is stored and when power is applied again, the progress returns to step 40 and is started from the last known data before power reset. Two-lamp turning on, four-lamp turning on, and turning off are described, but lamps may be increased or decreased by one lamp or three-lamp turning on or four-lamp turning on may be set as a group and the low illumination device may be continuously illuminated regardless of the door opening, that is, necessary illumination device may be used depending on the purpose.

By the above control, light reaction effect of photosynthesis can be obtained at four-lamp turning on and dark reaction of photosynthesis can be obtained at two-lamp turning on. Further, because a plurality of LEDs are

alternatively turned on, the LED life may be increased and thus replacement of light irradiation devices are unnecessary during the life of the refrigerator. Further, because the LEDs can be buried on the backside of the refrigerator, dew is prevented from attached, a degree of close contact can be increased, and because unintentional contact of a user is prevented, it is possible to prevent breakdown and secure safety. Further, it is not thought that light irradiation should be performed only when door is closed and because it is good to turn on without the detection of the opening and closing of the door, parts such as a door switch that is the detection means of the opening and closing for the door are not used. Thereby, it is possible to compose system at low cost and energy efficient. Furthermore, switching of turning on and turning off or switching of illuminance level using a signal generated during the opening and closing of the door can be freely performed by the setting of the microcomputer.

Further, illuminance may be controlled by setting current value so that current less than rated current secures about 100 Lx or about 300 Lx. Further, as years pass, the brightness of the LEDs declines, increasing the number of the LEDs to turn on at the same time drops, illuminance may be secured.

Further, in the refrigerator blowing cold air to the

vegetable chamber as in the other chambers instead of using radiation, water required for photosynthesis can be secured by blowing water generated during the frost operation to the vegetable chamber and thus photosynthesis can be promoted. Circulation of cold air and light irradiation from light source are completely unrelated to each other. That is, circulation of cold air is performed by fan operation or damper operation depending on the temperature detection in the refrigerator and necessary cold air is sent to necessary place. On the other hand, irradiation of light is intermittently performed by strong illumination for photosynthesis and is continuously performed by weak light source when opening the door. Further, in the vegetable chamber, etc., cold air is circulated to an upper part or surrounding of the receiving container, but is directed in the direction of food. By the circulation of less cold air, carbon dioxide existing in the refrigerator is supplied and dark reaction of photosynthesis is effectively performed.

Fig. 11 is a graph of the test results in the amount of the change of glucose and vitamin C when komatsuna is preserved for 3 days compared by light illuminance and an irradiation period of one day. Longitudinal axis shows as a percentage of each ingredient under each condition based on the amount of ingredients after 3 days when komatsuna is

preserved without irradiating light. That is, the 100% line in the graph indicates that each ingredient amount after 3 days is the same as even when compared with that of no irradiation. As shown in Fig. 11, result 60 shows the result when comparing increments of each ingredient of komatsuna after 3 days when irradiated to about 260 Lx for 3 hours in one day with that of no irradiation, where reduction of sugar or vitamin is greater than that of no irradiation. Further, result 61 is a test result when irradiated to 100 Lx, the effect declines, but when having the above construction, a function as a lamp in the refrigerator is fully performed, it is possible to distinguish the kind or item to preserve in a darkroom, for example, PET bottle beverage or seasoning, or vegetable or fruit. Therefore, light reaction of photosynthesis is fully generated by irradiating about 300 Lx for 3 hours in one day and dark reaction may be generated for the remaining 21 hours at 100 Lx or less in which light reaction is rarely generated or turning off. The test result is result 62 shown in Fig. 11.

Fig. 12 is a perspective view of another vegetable chamber according to the present invention. FIG. 13 is a cross-sectional view thereof. As shown in Fig. 2, the receiving container 30 is made of a material having no transmissibility and the second receiving container 31 is

made of a material having transmissibility, but as in Fig. 12, the second receiving container 31 is made of a material having no transmissibility and only some portion, where light is irradiated from the light irradiation device 32 of the back surface, is made of a material having no transmissibility and provided with a light-transmitting window 40. Then, it does not matter whether material of the receiving container 30 has no transmissibility or transmissibility.

According to the present invention having the above-composition, light irradiated to the second receiving container 31 that preserves leaf vegetables is reflected to the irradiated place in the container and the velocity of light of the LEDs is transmitted to vegetable without damage, whereby light intercepting ability to food preserved in the receiving container 30 is improved. Further, if an uneven portion is attached on the surface of the second receiving container 31, light causes scattered reflection or scattering, so that it is possible to promote photosynthesis effect in a more broad area with LEDs having strong directivity.

Figs. 14 and 15 are cross-sectional views of another vegetable chamber according to the present invention. As shown in Fig. 2, the receiving container 30 is made of a material having no transmissibility and the second

receiving container 31 is made of a material having no transmissibility, but as in Fig. 14, the second receiving container 31 is made of a material having no transmissibility and the receiving container 30 is made of a material having transmissibility and the light irradiation device 32 or the mounting substrate 33 is made to be inclined. When light is irradiated to the receiving container 30, light may be intercepted in the second receiving container 31.

According to the present invention having the above-composition, leaf vegetables having large leaf may be preserved in the receiving container 30 in the lower portion and root vegetables having small and narrow leaf and which is not proper to light irradiation may be preserved in the second receiving container in the upper portion 31, whereby they are neatly arranged. Further, as shown in Fig. 15, only some portion where light is irradiated is made of a material having transmissibility and the same effect may be obtained by a light-transmitting window 40. Further, in that case, the entire surfaces are made of reflecting material and thus it is possible to augment an effect of irradiated light.

Fig. 16 is a perspective view illustrating another vegetable chamber according to the present invention. In Fig. 2, the light irradiation device 32 is provided in a

plane of the second receiving container 31, but as shown in Fig. 16, it may be arranged in the side. Otherwise, it may be provided at the back side of an upper portion of the vegetable chamber 300 and provided to be inclined and thus
5 light which is irradiated to be inclined to the LED may to be irradiated to be inclined to the entire inside of the second receiving container 31, whereby reflection from the surface of the container or reflection due to an uneven portion provided in the surface of the container becomes
10 scattered reflection or causes scattering.

According to the present invention having the above-composition, because light emitted from the side surface or the back side of the upper surface is reflected to the side surface from facing plastic material, light is irradiated
15 without loss and thus the container having this structure obtains more effect than receiving container of other structure in preservation of vegetable. That is, even when the door is opened, light of the refrigerator does not go to the outside, so that the lamp more efficiently serves as
20 a lamp within the refrigerator and has an appeal effect in a store. As shown in Fig. 16, light source may be seen to be located in a central portion in the depth direction in the side, but for illumination in the refrigerating chamber or photosynthesis reaction, the back side of the central
25 portions is apt to reflect and is a desirable position.

Fig. 17 shows external appearance of the refrigerator having a separate structure, Fig. 18 is a cross-sectional view of the vegetable chamber thereof. As shown in Fig. 17, a refrigerator body denoted by reference numeral 1 includes a refrigerating chamber 100 having two opening and closing doors which open to right and left from the center of the uppermost portion of the refrigerator 1, an ice chamber 500 having an opening and closing door in the lower portion of the refrigerating chamber 100, a freezing chamber 200 having an opening and closing door in the lower portion of the ice chamber 500, and a vegetable chamber 300 which is arranged around the ice chamber 500 and the freezing chamber 200 and having an opening and closing door. As shown in Fig. 18, in the vegetable chamber 300 provided in the length direction, a drawer-type receiving containers 31a and 31b which is suitable for small fruit or tomato, a drawer-type receiving container 31c which is suitable for middle-size vegetables such as leaf vegetables, and a drawer-type receiving container 31d which is suitable for a pet bottle or large-size vegetables are arranged from the upside. The elements 32a, 32b, and 32c as light irradiation devices can irradiate light in each receiving container.

According to the present invention having the above-composition, it is possible to obtain the light irradiation

effect by light source as described above. Further, when using only the element 32b, if leaf vegetables preserve in the receiving container 31c and root vegetables which is not suitable for light irradiation preserve in the receiving containers 31a and 31b, it is possible to correspond to various kinds of vegetable preservation. Further, when the light irradiation device 32 is attached in plural, different color light irradiation devices may be provided such as the light irradiation device 32 consisting of the yellow LEDs, the light irradiation device 32 consisting of the red LEDs, the light irradiation device 32 consisting of the ultraviolet rays LEDs and leaf vegetables suitable for photosynthesis may preserve under a red light component, food that desires to restrain breeding of fungus may preserve under ultraviolet rays light, and food that desires to have balance effect may preserve under a yellow light component. Even if irradiation devices having such a plurality of kinds of other wavelength are always turned on, if jointly performing the above-mentioned control and raising illumination when a defrost operation performs, it is possible to illuminate at door opening and restrain bad effect. Further, if the light irradiation device is composed so that the LEDs 34 of the group light irradiation devices 32 is composed of a plurality of kinds of colored LEDs 34, for example, different color such as red or blue,

the group light irradiation devices can emit light of a plurality of wavelengths and thus vegetable can execute various photomorphogenesis, whereby color of light becomes color that gives warmth than single red and thus appearance of product or preserved food is improved. A structure or wiring of light source as described above is simplified by providing in plural LEDs that is a plurality of optical conductor elements in the mounting substrate 33, but light source may use when arranging one LED in one substrate or arranging one LED in the refrigerator chamber of the refrigerator. That is, by providing one element of 600 nm wavelength at the back side of the vegetable chamber, light source may use for illumination and vegetable preservation having high nutritive value at a turning on state always having low illuminance or by providing one element of about 600 nm wavelength at the back side of the lower portion of the refrigerating chamber, light source may use for turning on always having low illuminance. Further, during a defrost operation and for a predetermined time after a defrost operation, by controlling applied voltage to increase illuminance from low to high, it is possible to increase irradiation at night and increase vitamin by creating reducing sugar. Otherwise, by arranging one LED emitting ultraviolet rays at entrance of the refrigerating chamber, a pet bottle beverage that hates decolorization by

ultraviolet rays may store in the refrigerating chamber having less receiving amount. In this case, for sterilization, light source may be always turned on or turned off when opening a door and turned on when closing a door. Ultraviolet rays or red light component is not directly or in a single color seen when opening a door. Further, If LEDs having other wavelengths such as 600 nm are mixed, it is possible to check the inside of the refrigerator by emitting light of almost natural world which gives warmth and thus a refrigerator user can feel reassurance instead of dysphoria or worry when seeing or taking food.

In the above description, a place which does not irradiate light unit or a light interception portion which intercepts light from light source by a structure of the receiving container is mainly described. However, there is a refrigerator chamber having no a receiving container, for example, a structure which divides and stores food by providing shelves. A structure of Fig. 2 or Figs. 12 to 16, for example, a light interception portion is used as a structure of each shelf that is a receiving portion. For example, transparent or net shape structure which permeates light in a shelf or impermeable member may be used or a light irradiation window in a part of a shelf may provide or a structure scattering light in a shelf may be used.

Further, as shown in Fig. 4, the light irradiation device 32 is buried and fixed to the air duct 14, but as shown in Fig. 19, the light irradiation device 32 may arrange in the outside of the air duct 14 and fixed to the outside of the insulating portion by screws 39.

According to the present invention having the above-composition, it is possible to obtain the effects as described above and because the light irradiation device 32 is mounted to a wall of the refrigerator, when exchanged or removed, the air duct 14 may be not disjointed, so that it is possible to exchange the light irradiation device 32 and because it is easy to separate the light irradiation device 32 from an insulation material of the insulating portion, recycle of the insulation material is easy.

The light irradiation device 32 of the present invention is provided in the vegetable chamber 300, but it is provided in the refrigerating chamber 100, the freezing chamber 200, the ice chamber 400, and the switching chamber 500. In recent years, because the capacity of the vegetable chamber lacks or the refrigerating chamber has temperature lower than the vegetable chamber, vegetables may be preserved in the refrigerating chamber and thus the same effect can be obtained. Further, even if it is provided in any refrigerator chambers, it is used as a lamp of the refrigerator and when it is controlled to

intermittently use only for short time, when LEDs other than about 600 nm wavelength, for example, LED of ultraviolet rays and so on are individually used in the any chamber, it has less influence in color change of pet
5 bottle tea or juice, and has a sterilization effect of ice or preservation food and an effect that increases vitamin D in fragrant mushroom, etc.

As described above, the present invention has a receiving container mainly receiving vegetables in one
10 division of the vegetable chamber and a light irradiation portion is arranged on the backside of the receiving container. The light interception portion is provided in the receiving container and thus the receiving container has a division which irradiates light and a division which
15 does not irradiate light.

Further, the present invention uses a semiconductor light-emitting element as light source provided in the light irradiation portion and it is amber LED that outputs wavelength of visible ray area having a peak wavelength of
20 about 600 nm, and it does not deteriorate a sight effect of food kind.

Further, the present invention includes a plurality of LEDs as light source of the light irradiation portion and the LEDs are turned on or turned off in each
25 predetermined time and specifically, the respective LEDs

are turned on or turned off in each predetermined time and thus all LEDs are controlled not to turned off at the same time during an operation of the refrigerator or the brightness of LED group is declined after using for several
5 years, it is possible to increase the LED number to turn on at the same time and thus a great use effect or energy saving effect are obtained. Further, the structure is simplified if dividing the LEDs to a plurality of LED groups and controlling the divided LED groups.

10 Further, according to the present invention, the turning on number of LEDs is controlled, a period is set to irradiate with a high illuminance of light for several hours in one day, and a low illuminance of light is irradiated for the other period, so that it is possible to
15 obtain a preservation effect and energy saving effect.

Further, according to the present invention, by operating the refrigerator with an operation panel or a remote control provided in a door of the refrigerator, an operation panel in the refrigerator, and a cellular phone
20 using communication, for example, a light irradiation function may be suspended or temperature set of the refrigerator chamber and illumination may be performed at the same time.

Further, according to the present invention, it is
25 possible to increase food preservation performance by

raising illuminance of light to irradiate in a special time duration such as during a defrost operation and for several hours after the defrost operation.

Further, the refrigerator according to the present invention includes a light irradiation device for irradiating light having peak wavelength of the range from about 590 nm to 600 nm, a light interception portion for limiting irradiation area, and a turning on controller and light giving warmth can use as illumination of the refrigerator. Further, the light irradiation device is provided on the backside of the receiving container or to be irradiated to be inclined from the side surface or the upper surface thereof and because light is irradiated to the entire reception, nutritive substance is increased without damaging appearance of vegetables. The light irradiation device of the refrigerator according to the present invention makes the LED to intermittently irradiate or is provided in plural and controlled so that turning on is alternately performed by each LED and thus the LED life may be increased.

As described above, according to the present invention, by using individually or in plural by combining monochromatic light emitting diode, light is irradiated to food other than vegetables and photosynthesis reaction is controlled and thus it is possible to obtain a food

preservation effect or nutrition effect by creating reducing sugar and increasing vitamin C, and sterilization effect and so on. By dividing into individual or group the plurality of light emitting diode and connecting to power in parallel and providing LED which emits light and LED which does not emit, the efficient device is obtained which does not much energy, has long life because exchange of the device is unnecessary, and does use useless energy, and the composition to control the device will be described. Next, other control composition and operation will be described with reference to Fig. 20. Fig. 20 is a circuit diagram of the light irradiation device when turning on the light irradiation device by a different method as shown in Fig. 7. As shown in Fig. 20, current is limited to several tens mA or several mA by providing each LED 34a, 34b, 34c, and 34d and resistance that determines current value flowing to the LEDs in series. Further, signals from a control device such as a microcomputer are output to the input of the transistor provided in series, depending on on or off period of LED and an electric circuit that repeats the turning on and turning off of LED is composed and a rapid cycle (for example, about 4 kHz) which cannot feel twinkle when turning on LED becomes 1 cycle and current-carrying/interception is alternately performed to the LED for the cycle.

Further, a ratio (the rate of electric current) of current-carrying/interception can be voluntarily controlled by a control device such as a microcomputer to control on or off of the transistor. Fig. 21 is a diagram illustrating current-carrying rate, a ratio of current-carrying period for 1 cycle. Adjustment of illuminance of the entire light irradiation device is made by adjusting the rate of electric current. Further, although the life of LED depends on the current-carrying period, as in this method, the life of LED can be increased if setting interception time when turning on the LED. Further, LED light can be prevented from being gradually seen if a period of current-carrying/interception is set to be faster than sense of human eye.

Further, if employing this electric circuit, consumption current is further decreased and thus energy saving can be obtained. If this cycle is preset, it may be freely selected as needed.

Further, because LED illuminance lowered by deterioration depending on current-carrying period increases, a ratio (the rate of electric current) of current-carrying/interception time is adjusted, it is possible to changelessly maintain LED illuminance for long term. Fig. 22 is a diagram illustrating a modified example of the rate of electric current. If power is applied to

the refrigerator, at first an initial current-carrying ratio is turned on to 60% (step 50). When 1 year is passed after power is applied (step 51), a current-carrying ratio is changed to 70% (step 52). When 5 years are passed after power is applied (step 53), a current-carrying ratio is changed to 80% (step 54). Because illuminance characteristic, etc. is different depending on the kind and the number of the light-emitting element using, the rate of electric current and using time may be adjusted so that necessary lowest illuminance is always obtained if selecting a numerical value by grasping data. Further, as shown in Fig. 7, by the number change and combination of LEDs to turn on, it is possible to obtain an efficient device and a device whose replace is unnecessary during using period of the refrigerator. Further, as shown in the Figs. 22 and 23, a composition of increasing the number of the LEDs to be turned on depending on operation time or the rate of electric current is described, but because it is good to increase the number of the LEDs to be turned on or the rate of electric current depending on deterioration of the LEDs, for example, a composition of detecting and changing illuminance may be employed by providing a switch to short a part of current limitation resistance.

A light source device having a composition to be performed on or off operation with a rapid cycle by

providing each LED as shown in Fig. 20 in series may be protected into a bundle by a permeable cover 35 as shown in Fig. 4. By this way, the light source device can be fixed without change of the irradiation angle regardless of vibration of the refrigerator and short of circuit in the back side is prevented thanks to coating by the seal 36, by interposing O-ring 38 to prevent the light source device from being exposing to the cover 35, a degree of close contact of the light source device to the mounting substrate is increased and thus cold air is intercepted and the mounting substrate 33 is exposed or irregular reflection of light by trickle is prevented. Further, as shown in Fig. 19, because the cover 35 has a protrusion 39, the receiving container is prevented from being bumped on the cover surface and diffused reflection of light by damage of the cover surface is prevented or breakdown or damage of the mounting substrate 33 and the LEDs 34 is prevented.

The light source device may be controlled in series by arranging so that the light source device having a composition to perform on or off operation in a cycle faster than twinkle in which human eye feels by providing each LED as shown in Fig. 20 in series has other specific wavelength in the vegetable chamber as shown in Fig. 18. That is, as shown in Fig. 18, in the vegetable chamber 300,

a drawer-type receiving containers 31a and 31b which is suitable for small fruit or tomato, a drawer-type receiving container 31c which is suitable for middle-size vegetables such as leaf vegetables, and a drawer-type receiving
5 container 31d which is suitable for a pet bottle or large-size vegetables are arranged from the upside and the elements 32a, 32b, and 32c as light irradiation devices can irradiate light in each receiving container. By having such a composition, the same effect can be obtained as that
10 of light irradiation by light source as described above.

When using only the element 32b, if leaf vegetables preserve in the receiving container 31c and root vegetables which is not suitable for light irradiation preserve in the receiving containers 31a and 31b, it is possible to
15 correspond to various kinds of vegetable preservation. Further, when the light irradiation device 32 is attached in plural, different color light irradiation devices may be provided such as the light irradiation device 32 consisting of the yellow LEDs, the light irradiation device 32
20 consisting of the red LEDs, the light irradiation device 32 consisting of the ultraviolet rays LEDs and leaf vegetables suitable for photosynthesis may preserve under a red light component, food that desires to restrain breeding of fungus may preserve under ultraviolet rays light, and food that
25 desires to have balance effect may preserve under a yellow

light component. Even if irradiation devices having such a plurality of kinds of other wavelength are always turned on, if jointly performing the above-mentioned control and raising illumination when a defrost operation performs, it is possible to illuminate at door opening and restrain bad effect. Further, if the light irradiation device is composed so that the LEDs 34 of the group light irradiation devices 32 is composed of a plurality of kinds of colored LEDs 34, for example, different color such as red or blue, the group light irradiation devices can emit light of a plurality of wavelengths and thus vegetable can execute various photomorphogenesis, whereby color of light becomes color that gives warmth than single red and thus appearance of product or preserved food is improved. A structure or wiring of light source as described above is simplified by providing in plural LEDs that is a plurality of optical conductor elements in the mounting substrate 33, but light source may use when arranging one LED in one substrate or arranging one LED in the refrigerator chamber of the refrigerator.

As described above, according to the refrigerator of the present invention, it is possible to perform a control which does not use useless energy, that is, use as illumination by turning on when closing a door and when opening a door and use as a lamp of the inside of the

refrigerator by increasing nutritive substance without
damaging appearance of food such as vegetables by
performing the control to turn on or turn off LEDs of a
plurality of specific frequency regardless of the same
5 frequency or different frequency at the same time or
different time with an illumination device having a
combination composition which does not seem to use red or
blue as monochrome or raising illuminance of light source
having a preservation effect of food such as vegetables at
10 night time duration. Further, because light source of the
refrigerator of the present invention makes LEDs to
intermittently irradiate, each LED is provided not to be
turned on instantaneously or by converting in the
predetermined cycle, and alternative control of the LEDs to
15 save energy, it is possible to increase the LED life and
thus obtain the refrigerator having good efficiency.

Further, by operating of operating means provided at
inside or outside the refrigerator the LEDs of a plurality
of kinds of other specific wavelength which are provided in
20 the refrigerator room or in shelves depending on food to
receive, semiconductor light-emitting elements as light
source are selected and thus a switch to select wavelength
of light is converted or turned off individually at a
preset time, whereby it is possible to obtain a convenient
25 refrigerator. For example, by providing a LED selection

switch that is temperature control panel in the refrigerator and selecting and turned on a LED substrate having each different wavelength or by mounting plurality of kinds of LEDs having different wavelength to a single
5 LED substrate and selecting and controlling wavelength of the kind of turned on LED among them, vitamin is increased and thus LED having wavelength is selected depending on a purpose of increasing nutritive substance, whereby it is possible to turned on in preset control contents.

WHAT IS CLAIMED IS:

1. A refrigerator comprising:

a plurality of light sources disposed on the backside
5 of the inside of a refrigerator to irradiate light with a
wavelength mainly giving warmth; and

a control device which individually controls the
turning on and turning off of the plurality of light
sources and is provided in a refrigerator body.

10

2. A refrigerator comprising:

a plurality of light sources disposed on the backside
of the inside of a refrigerator to irradiate light with a
wavelength mainly giving warmth;

15 a receiving container disposed in a refrigerator to
receive food; and

a light shielding part disposed in the receiving
container to shield light from the light sources,

wherein places that irradiate light and places that
20 do not irradiate light are provided in the receiving
container.

3. The refrigerator according to claim 1,

wherein a yellow light component or an orange light
25 component which outputs visible rays in a wavelength range

from about 590 to 600 nm is emitted individually or in combination with other color light by using semiconductor light-emitting elements as the light sources.

5 4. The refrigerator according to claim 1, further comprising

 a plurality of the receiving containers disposed in the refrigerator to receive food,

 wherein the light from the light sources is reflected
10 or scattered by irradiation to a specific position of the receiving containers.

 5. The refrigerator according to claim 1,
 wherein the semiconductor light-emitting elements as
15 the light sources are turned on or turned off at a preset time.

 6. The refrigerator according to claim 1,
 wherein the semiconductor light-emitting elements as
20 the light sources are divided into a plurality of groups and the light sources are turned on or turned off by each group.

 7. The refrigerator according to claim 1,
25 wherein the number or the group number of

semiconductor light-emitting elements as the light sources to be turned on is controlled during the operation of the refrigerator.

5 8. The refrigerator according to claim 1,
 wherein the semiconductor light-emitting elements as
the light sources are controlled so as not to be turned off
at the same time during the operation of the refrigerator.

10 9. The refrigerator according to claim 5,
 wherein the number or the group number of the
semiconductor light-emitting elements as the light sources
to be turned on at the same time is increased with the
lapse of the operation of the refrigerator.

15 10. The refrigerator according to claim 5,
 wherein the number of the semiconductor light-
emitting elements as the light sources to be turned on or a
current-carrying ratio of the light sources is controlled
20 so that a time duration to be irradiated by a high
illuminance of light and a time duration to be irradiated
by a low illuminance of light are set.

 11. A refrigerator comprising:
25 a plurality of semiconductor light-emitting elements

disposed on the backside of the inside of a refrigerator to irradiate a specific wavelength of light; and

a control device set to always turn at least one of the semiconductor light-emitting elements and provided in a refrigerator body.

12. The refrigerator according to claim 1,
wherein the illuminance of light to be irradiated is set high for a defrost operation and several hours after the operation.

13. The refrigerator according to claim 1, further comprising

a cover that covers the semiconductor light-emitting elements as the light sources, and passes light but intercepts cold air without communicating with the inside of the refrigerator,

wherein the semiconductor light-emitting elements and the cover are fixed to the refrigerator body.

14. The refrigerator according to claim 1,
wherein when turning on semiconductor light-emitting elements as the light sources, current-carrying/interception is repeated in rapid cycles without a noticeable change.

15. The refrigerator according to claim 14,
wherein a current-carrying/interception ratio is
adjusted depending on the illuminance decline of the
5 semiconductor light-emitting elements or the elapsed time
of the operation.

16. A refrigerator comprising:
a plurality of light sources disposed inside a
10 refrigerator to irradiate a specific wavelength of light,
respectively; and

a control device provided in a refrigerator body to
control turning on of the plurality of light sources so as
to increase the illuminance of light to be irradiated
15 during a specific time duration,

wherein the illuminance of the plurality of light
sources is controlled by controlling the number of the
plurality of light sources or by changing a current-
carrying ratio within a cycle that performed repeated
20 current-carrying.

17. A refrigerator comprising:
a plurality of light sources disposed inside a
refrigerator to irradiate a specific wavelength of light;
25 a cover that covers the semiconductor light-emitting

elements as the light sources, passes light but intercepts cold air without communicating with the inside of the refrigerator, and is sealed by a seal; and

a control device which is disposed in a refrigerator body so as to control the turning on and turning off of the light sources and which controls individually turning on and turning off the semiconductor light-emitting elements as the light sources.

10 18. The refrigerator according to claim 1,
 wherein a light irradiation function is stopped by operating an operating means provided inside or outside the refrigerator.

15 19. The refrigerator according to claim 1,
 wherein the temperature inside the refrigerator to perform light irradiation from the light sources is changed by operating an operating means provided inside or outside the refrigerator.

20 20. The refrigerator according to claim 1,
 wherein the inside of the refrigerator are divided into a plurality of refrigerator chambers, the light sources are arranged in at least one of the refrigerator
25 chambers set to a refrigerating chamber temperature of 0°C

or more, a vegetable chamber temperature, and a freezing chamber temperature, and the irradiation direction of light from the light sources arranged in the refrigerator chambers is almost the same direction as a forward
5 direction or a backward direction of cold air that is circulated in the refrigerator chambers.

21. The refrigerator according to claim 1,
wherein an operating means disposed inside or outside
10 the refrigerator is operated to select the semiconductor light-emitting elements to irradiate light as the light sources and to select the wavelength of light.