

[Name of Document] SPECIFICATION

[Title of the Invention] REFRIGERATING METHOD AND
REFRIGERATOR-FREEZER FOR FOOD

[Technical Field]

[0001]

The present invention relates to a refrigerating method and a refrigerator-freezer for food utilizing a refrigerating technology.

[Background Art]

[0002]

There have been increasing cases in which rice cooked at home is frozen at home in a refrigerator for household use. Freshly steamed rice is said to be the most delicious, but much time and labor are required to cook a necessary amount of rice when necessary.

Therefore, freezing and storage of cooked rice is generally conducted as a simple and convenient storage method similar to thermal insulation in a rice cooker.

[0003]

However, considering a case in which rice cooked in a larger quantity is kept warm in a rice cooker and eaten separately several times, the rice having been kept warm might become yellow, dry and hard or begin to smell with time, and it is therefore not possible to eat rice as delicious as freshly steamed rice.

Thus, in order to overcome the above problems, a rice-cooking device has been developed, the rice-cooking device including a container for storing rice, heating means for heating and thermally insulating rice at 71 to 73 degrees in the container, and pressure-reduction means for reducing the pressure inside the container to 20 to 93 kPa (See Patent Document 1, for example).

[0004]

Also, if rice cooked in a larger quantity is to be frozen and stored and then, thawed by a microwave to be eaten, when the rice is to be frozen at home, the rice is left at a room temperature in order to remove residual heat and then, frozen in a freezing compartment.

This is because warm food directly placed in the freezing compartment might adversely affect frozen foods already stored in the freezing compartment. However, to cool down rice to room temperature before freezing requires labor in that two steps are needed in the rice storage process, and also it is not good for the quality of the rice.

In order to solve the above problems, a refrigerator has been developed in which foods with residual heat are placed in a space with a small capacity and target foods are rapidly cooled (See Patent Document 2, for example) and a refrigerator has been developed in which a cooling unit in which warm food is to be placed is provided in a

refrigerating compartment (See Patent Document 3, for example).

[0005]

Also, if rice having been cooked in a larger quantity is to be frozen and stored, other than the required labor, there are many complaints that the rice thawed by a microwave tends to be hard, dry, and not delicious.

Thus, there are many proposals for suppressing deterioration of the food quality when rice is frozen. For example, there is a refrigerating method for refrigerating processed food in which a cooling speed for rice is regulated and the maximum ice-crystal generation-belt passage time is set at 15 to 20 minutes so that a quality substantially equal to that before refrigeration is obtained when the food is being thawed naturally or by a microwave (See Patent Document 4, for example), and there is also a manufacturing method for producing frozen rice in which cooling is temporarily stopped during a rapid refrigerating process of the rice, the temperature inside a refrigerating compartment is rapidly raised within a time during which the frozen rice does not thaw and the rice is left for a short while and then, rapidly frozen again so as to refrigerate the rice (See Patent Document 5, for example).

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2005-253318 (page 1, Fig. 1)

[Patent Document 2] Japanese Unexamined Patent
Application Publication No. 2007-212053 (page 1, Fig. 1)

[Patent Document 3] Japanese Unexamined Patent
Application Publication No. 2005-226984 (page 1, Fig. 1)

[Patent Document 4] Japanese Unexamined Patent
Application Publication (Translation of PCT Application) No.
9-500542 (page 1, Fig. 1)

[Patent Document 5] Japanese Unexamined Patent
Application Publication No. 5-23121 (page 1, Fig. 1)

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0006]

A rice cooker for keeping rice warm while storage odor or yellowing is prevented is described in Patent Document 1, but a storage period is not clearly referred to, and considering characteristics of a general rice cooker, storage for about a couple of days is assumed. Therefore, even if rice can be stored in a state close to a freshly steamed state, the storable period is extremely short and does not achieve a level that a frequency of rice cooking is reduced so as to alleviate a burden of housekeeping.

[0007]

A merit in freezing of rice having been cooked in a larger quantity at home is that the rice can be stored for a long time and moreover, both appearance and texture of the

rice immediately after thawing by a microwave become close to a freshly steamed state as compared with the rice kept warm in a rice cooker for a long time. However, the rice after being thawed by a microwave easily becomes hard with time, and the food quality becomes far from the rice before freezing.

In order to solve the problem, a refrigerator in which foods with residual heat are placed in a space with a small capacity and target foods are rapidly cooled is described in Patent Document 1, but it is only to rapidly freeze the rice in a warm state, and the food quality after thawing does not become dramatically better.

[0008]

As a method for improving eating quality of refrigerated rice, Patent Document 3 describes a refrigerator having a device capable of cooling at an extremely low temperature during freezing, but the refrigerator needs to use a device capable of cooling at an extremely low temperature and becomes bulky and complicated as a device for freezing extra rice at home.

[0009]

The present invention was made in order to solve the above problems and provides a refrigerating method and a refrigerator-freezer for food that can cool warm food such as freshly steamed rice by cooling the warm food such as

freshly steamed rice in a concentrated manner via an supercooled state in the process of freezing so that labor to remove residual heat can be saved at cooling or freezing and moreover, quality after refrigeration and thawing is improved, and the effect can be obtained by improving a method of cooling and freezing.

[Means for Solving the Problems]

[0010]

The refrigerating method according to the present invention is, in a refrigerating method for refrigerating food containing starch such as rice, carried out such that rapid cooling is conducted at a cooling speed of 0.5°C / minute or more when the food temperature is high, the rapid cooling is stopped so as to decrease the cooling capacity when a temperature on the food surface falls within a temperature range of 40 to 1°C , and when the food temperature reaches the vicinity of a freezing point temperature after that, the cooling capacity is raised within a range such that an air temperature around the food does not fall to -15°C or below for rapid cooling, and after rapid cooling is conducted again after a predetermined time has elapsed, regular refrigeration is conducted.

[Advantages]

[0011]

The refrigerating method for refrigerating food

according to the present invention is, in a refrigerating method for refrigerating food containing starch such as rice, rapid cooling is conducted at a cooling speed of 0.5°C / minute or more when the food temperature is high, the rapid cooling is stopped so as to decrease the cooling capacity when a temperature on the food surface falls within a temperature range of 40 to 1°C , and when the food temperature reaches the vicinity of a freezing point temperature after that, the cooling capacity is raised within a range such that an air temperature around the food does not fall to -15°C or below for rapid cooling, and after rapid cooling is conducted again after a predetermined time has elapsed, regular refrigeration is conducted. Thus, since food at a high temperature such as freshly steamed rice can be rapidly cooled without removing residual heat, chemical change such as aging or breeding of bacteria occurring at a temperature higher than a freezing temperature of the food is suppressed, evaporation of moisture contained in the food is restrained, and moreover, since the food is frozen after supercooling, an internal structure of the food is not destroyed by ice crystals generated by freezing but high-quality storage is achieved, and due to fineness of the ice crystals and positions where the ice crystals are generated, re-gelatinization is promoted when being warmed again in the case of foods

containing starch such as rice, and an effect is exerted that food quality close to that before freezing can be maintained as compared with conventional thawed products after freezing.

[Best Mode for Carrying Out the Invention]

[0012]

Embodiment 1

Fig. 1 is a schematic diagram illustrating a difference between a refrigerating method for refrigerating food in Embodiment 1 of the present invention, particularly a refrigerating method for refrigerating rice, and a prior art refrigerating method for rice, Fig. 2 is a graph illustrating the texture of rice frozen by the refrigerating method, and Fig. 3 shows graphs illustrating temperature change when water is frozen without supercooling (a) and with supercooling (b).

The refrigerating method proposed as Embodiment 1 of the present invention is a refrigerating method suitable for freezing food containing starch such as rice in a state with good quality and particularly a refrigerating method suitable for rice.

Even for foods other than those containing starch such as rice, an effect to improve the refrigerating quality of food can be obtained as long as the food is warm food.

The refrigerating method and means for realizing that

will be described below using rice as an example.

[0013]

First, a difference between the refrigerating method for refrigerating food in Embodiment 1 of the present invention, particularly a refrigerating method for refrigerating rice, and a prior art refrigerating method for refrigerating rice will be described using the schematic graph in Fig. 1. In Fig. 1, the vertical axis denotes a temperature, the lateral axis denotes time elapsed, a solid line denotes food core temperature, and a broken line denotes food surface temperature.

[0014]

(X) in Fig. 1 indicates a temperature change of rice in refrigeration by the prior-art refrigerating method.

In the prior-art refrigerating method, residual heat is removed by leaving warm rice at room temperature before refrigeration. Therefore, in a temperature range A, chemical reactions leading to breeding of bacteria, changes in the color and odor of the rice, and quality deterioration relating to food quality can easily progress.

Also, when the rice remains in a temperature range B for a long time, aging of starch causing the rice to become hard, dry and separated can easily progress.

Also, at a regular freezing temperature as in a temperature range of C, during a process in which freezing

starts at the surface and proceeds to completion through a phase change, moisture is drawn to the surface where freezing initially takes place during the freezing process, and the moisture in rice grains tends to escape easily, and moreover, since ice crystals grow and become large and needle shaped, the surface area where starch molecules and water molecules are in contact with each other becomes small during thawing, and re-gelatinization and a return to a soft state become difficult.

[0015]

(Y) in Fig. 1 denotes a temperature change of rice in the refrigerating method of the present invention.

In the refrigerating method of the present invention, since freshly steamed rice can be placed in a switching compartment for which a refrigerating temperature range can be set for rapid cooling, the chemical reactions in the temperature range A leading to breeding of bacteria, changes in the color and odor of the rice, and quality deterioration relating to food quality can be suppressed.

Also, in the temperature range B, since rapid cooling is conducted on the rice in an unfrozen state when the rice is at a high temperature and in a phase change, the time in this temperature range can be reduced, and aging of starch can be suppressed.

Also, by freezing via a supercooled state as in the

temperature range C, since fine ice crystals are generated on the whole at the center of the rice grain, the surface area where starch molecules and water molecules are in contact during thawing is large, re-gelatinization and a return to a soft state are easy, and food quality close to that achieved just after steaming can be obtained.

[0016]

A detailed cooling method in each cooling process will be described for (Y) in Fig. 1.

In the temperature range A, the temperature of freshly steamed rice is as high as 60 to 90°C, and the time needed for the rice core temperature to cool down from 60°C to 10°C is within 100 minutes or preferably within 70 minutes for 150g rice wrapped in plastic wrap. That is, the cooling speed is 0.5°C / minute or more or preferably 0.7°C / minute or more.

[0017]

The temperature range B is a temperature range where aging of starch can easily progress and refers to a range from 40°C to a temperature at completion of freezing or preferably from 10°C to a freezing point -2°C (the freezing point -2°C after going through the phase change via the supercooled state and cancellation of the supercooling).

Supposing that the time during which the rice core temperature changes from 10°C to -2°C is within 600 minutes

for 150g rice wrapped in plastic wrap, for example, more preferably within 300 minutes, or still more preferably within 100 minutes, a tendency to suppress starch aging is found.

By freezing via the supercooled state in the region C, an effect to improve the freezing quality can be expected, and an effective effect can be obtained in the freezing quality improvement if a degree of supercooling (a temperature difference between the freezing point of the food and the temperature reached by supercooling) is 1°C or more, preferably 3°C or more, or more preferably 5°C or more.

[0018]

Fig. 2 shows a texture measurement result for rice. The term "texture" means dynamic characteristics felt when the food is masticated. In the figure, the vertical axis indicates viscosity, while the lateral axis indicates hardness.

If rice thawed after freezing is plotted at a position close to that for freshly steamed rice in the figure, it can be considered that food quality close to that of freshly steamed rice can be obtained in eating.

The rice of the present invention which is rapidly cooled while being warm and frozen via the supercooled state (the degree of supercooling is 1°C or more, preferably 3°C or more, or more preferably 5°C or more) is plotted at a

position closer to that for freshly steamed rice than that for rice of the prior-art refrigerating method and shows a result that both hardness and viscosity are close to steaming.

[0019]

Here, supercooling of water will be described.

Fig. 3 shows graphs illustrating temperature changes when water is frozen without supercooling (a) and with supercooling (b). The vertical axis in the graph indicates temperature, and the higher up the graph temperature is plotted, the higher the temperature is. The lateral axis indicates time, and a change with time is indicated by an arrow direction.

The supercooled state refers to a temperature at which the substance starts freezing. That is, the supercooled state is a state in which the substance is not frozen at all though it should start freezing at that temperature. For example, the freezing point of water is 0°C . The freezing point varies depending on the substance, and it tends to be lower than 0°C for foods with high salt concentration or sugar content.

[0020]

The supercooled state and freezing via the supercooled state will be described in more detail using water as an example. The supercooled state means a state of 100% water

when water is cooled, even though the temperature falls under 0°C, which is the freezing point.

Water in the supercooled state is also frozen in the end and can become ice, but some stimulation is required at this time. The stimulation may be provided as a change in temperature or as physical stimulation.

The freezing can be started by stimulation as above, but the time from the supercooled state to the start of freezing is in the order of several seconds and instantaneous. However, a proportion of ice frozen instantaneously at the start of the freezing is equivalent to several percents of the whole, and more cooling time is required till 100% of the water becomes ice.

[0021]

Here, a difference between regular freezing and supercooled freezing will be described. First, the biggest difference between regular freezing and supercooled freezing is whether the supercooled state is entered or not. In the case of regular freezing, if the freezing point is passed, the freezing starts without the food entering the supercooled state.

[0022]

Another significant difference between regular freezing and supercooled freezing is the state of the food when freezing starts. Here, what phenomenon is occurring at the

start of freezing will be described using water in a PET bottle as an example. In the case of regular freezing, when freezing starts, water in the vicinity of the PET bottle surface starts freezing, which brings about a state in which thin ice is formed on the surface portion, and then, this ice expands toward the inside and the whole is frozen in the end.

[0023]

Growth of ice occurs around an ice nucleus in which a water molecule forms a cluster of a certain size or more, and ice nucleation occurs at the start of freezing. Therefore, in the case of regular freezing, most of the ice nuclei have been formed on the surface, and it can be considered that ice is growing toward a portion which is in a liquid state.

On the other hand, in the case of supercooled freezing, if freezing starts, ice nuclei are formed uniformly throughout the entire PET bottle. Since ice grows everywhere both inside and on the surface of the PET bottle, ice does not grow in a certain direction.

The difference between regular freezing and supercooled freezing after freezing has been completed is that large needle-like ice crystals are formed toward the inside from the surface in the case of regular freezing, while small grain-like ice crystals are uniformly formed on the surface

and inside in the case of supercooled freezing.

[0024]

Also, in the case of rapid freezing, the state of the food after freezing has been completed is similar to that in the case of regular freezing from the viewpoint that cold air is applied to the surface for quick freezing. Since the temperature on the surface is rapidly lowered, the freezing starts on the surface.

However, a difference between rapid freezing and regular freezing is that since, in a rapid freezing, cooling toward the inside progresses at high speed, the ice nuclei can be easily formed in the inside as well as on the surface, as compared with regular freezing, and large ice crystals are not formed as in the case of regular freezing.

[0025]

Considering food refrigeration, the size and shape of ice crystals after freezing has been completed have a big influence on food quality when the food is thawed. Since most food is constituted by cells, proteins, carbohydrates and the like, once the structure is destroyed by ice crystals, it is not fully recoverable in many cases.

Therefore, it can be said that refrigeration with good quality is realized if the size and shape of ice crystals formed during freezing do not destroy the original structure of the food.

[0026]

With regard to rice, in the case of freezing via the supercooled state, since fine ice crystals are formed at the center of rice grains on the whole, it can be assumed that the surface area where starch molecules and water molecules are in contact during thawing is large, and re-gelatinization and a return to a soft state are easy.

The supercooled state can be kept, and thus food may remain unfrozen without cancellation of supercooling, but in the case of rice, if it is in the unfrozen state, aging of starch progresses. Therefore, in the case of supercooled freezing of rice, the supercooled state needs to be cancelled immediately so that the rice can be fully frozen.

[0027]

Subsequently, a structure and control of a refrigerator-freezer for carrying out the refrigerating method in Embodiment 1 of the present invention will be described in detail.

Fig. 4 is a side sectional view of the refrigerator-freezer for carrying out the refrigerating method, Fig. 5 is a side sectional view showing a switching compartment of the refrigerator-freezer for carrying out the refrigerating method, Fig. 6 is an exploded perspective view of an infrared sensor of the refrigerator-freezer for carrying out the refrigerating method, Fig. 7 is a graph showing

directivity characteristics of the infrared sensor of the refrigerator-freezer for carrying out the refrigerating method, Fig. 8 is a side sectional view illustrating the switching compartment of the refrigerator-freezer for carrying out the refrigerating method, Fig. 9 is a perspective view illustrating the periphery of a sensor mounting portion of the switching compartment of the refrigerator-freezer for carrying out the refrigerating method, and Fig. 10 is a perspective view illustrating a switching case of the refrigerator-freezer for carrying out the refrigerating method.

[0028]

As shown in Fig. 4, a food storage compartment of the refrigerator-freezer for carrying out the refrigerating method in Embodiment 1 of the present invention is mainly constituted by a refrigerating compartment 100 arranged at an uppermost part and provided with an opening / closing door, a switching compartment 200 arranged below the refrigerating compartment 100 and provided with a drawer door capable of switching from a freezing temperature range (-18°C) to temperature ranges such as refrigerating, vegetables, chilled, soft freezing (-7°C) and the like, an ice-making compartment 500 arranged side by side to the switching compartment 200 and provided with a disk drawer door, a vegetable compartment 300 arranged at a lowermost

part and provided with a drawer door, and a freezing compartment 400 arranged between the vegetable compartment 300 and the switching compartment 200 as well as the ice-making compartment 500 and provided with a drawer door.

On the door surface of the refrigerating compartment 100, an operation panel 10 for adjusting a setting of each compartment is provided, and on the back face side of the refrigerating compartment 100, a controller 16 is provided for controlling a compressor and opening / closing of a damper so that a temperature of a temperature detector installed at each compartment is adjusted to the temperature operated and set by the operation panel 10.

The switching compartment 200 and the freezing compartment 400 of the refrigerator-freezer are spaces in which rapid cooling and supercooling control are possible.

[0029]

As shown in Fig. 5, on the front side of a ceiling in the switching compartment 200, a thermopile 2, which is an infrared sensor for sensing a temperature of a placed food such as rice, is mounted.

Also, at an upper part on the back face side of the switching compartment 200, a thermistor for detecting an air temperature inside the switching compartment 200 is mounted.

This thermopile 2 is provided to be rotated by 90 degrees or more using a mounting point as a spindle so that

a temperature of the food stored at any position in a switching case 201 contained in the switching compartment 200 can be detected. The thermopile 2 may be provided to be rotated by 180 degrees in the horizontal direction using the mounting point as a spindle so that temperature of the food stored at any position in the switching case 201 can be detected.

The air temperature detected by the thermistor 3 is used for damper control for keeping the temperature of the switching compartment 200 at a set temperature, and if the detected temperature of the thermistor 3 is higher than the set temperature, the damper, which will be described later, is opened so as to feed cold air into the switching compartment 200, while if it is lower than the set temperature, the damper is closed so as to prevent cold air inflow into the switching compartment 200.

[0030]

Subsequently, the thermopile 2 will be described in detail referring to Figs. 6 to 9.

As shown in Fig. 6, the thermopile 2 for sensing the food temperature is constituted by a thermopile substrate 30, which is an infrared sensor main body, a movable casing 31 to which the thermopile substrate 30 is integrally mounted and which protects the thermopile substrate 30, a driving motor 32 for rotating and driving the movable casing 31 to

which the thermopile substrate 30 is mounted, and a fixed casing 33 to which the driving motor 32 is mounted and fixed and which has a window portion covering the movable casing 31.

The thermopile 2 measures temperature using an infrared ray from a target and it has directional characteristics as shown in Fig. 7 in sensing.

Therefore, in order to improve sensing accuracy of the thermopile 2, it is important to catch the target to be measured at the center of the sensor as much as possible. Thus, it is configured such that the thermopile 2 is moved so as to position the target to be measured at the center.

[0031]

As the driving motor 32, a stepping motor capable of position detection at rotation is suitable. However, if the motor is to be operated in an environment in the refrigerator or particularly in a freezing temperature range, gelation due to inflow of humidity in opening / closing of a door of the refrigerator should be considered.

Thus, in order to ensure a certain degree of a rotation output torque, a gear speed-reduction mechanism may be provided between an output shaft of the driving motor 32 and the movable casing 31.

Also, in order to restrain a failure due to frost formation on the thermopile substrate 30, a double structure

is provided in which the thermopile substrate 30 is covered by the movable casing 31, and the movable casing 31 is further covered by the fixed casing 33 so as to ensure reliability.

The casings 31, 32 may be made of a general plastic material, but the window portion of the fixed casing 33 receiving the infrared ray is preferably covered by a material such as silicon and polyethylene which can easily transmit the infrared ray.

[0032]

Fig. 8 shows a mounting position of the thermopile on the switching compartment, and Fig. 9 shows a detailed structure of the mounting position of the thermopile.

The thermopile 2 configured as above is installed on the ceiling above the switching compartment 200, which is a compartment to be measured.

That is because, if there is the switching case 201 or the like for storing food at least in the switching compartment 200 to be sensed by the thermopile 2, the food itself can not be sensed unless the thermopile is installed above the height of the switching case 201.

Also, interference by food or a human hand with a mechanism portion of the driving motor 32 or the like of the thermopile 2 during the door opening / closing operation and food placement becomes a factor to cause nonconformity.

[0033]

Thus, as shown in Figs. 8 and 9, the fixed casing 33 of the thermopile 2 is mounted by a screw 35 on a sensor-mounting member 205 provided with a recess portion having a size that can be contained by the ceiling of the switching compartment 200 to be sensed.

Moreover, the mounting position of the thermopile 2 is preferably in the vicinity of a region for which sensing accuracy is to be enhanced. The reason is that the smaller a distance between target food and the sensor becomes, the more advantageous it is since a share by the food in the view field area becomes high, and moreover, a chance that the target food is placed in a blind of another food is smaller.

Therefore, in the case of Embodiment 1 in which warm food is assumed to be usually placed in the front portion of the switching case 201, for example, as shown in Fig. 8, the thermopile 2 is installed on the ceiling of the front portion of the switching case 201 so as to realize a system configuration resistant against disturbance.

[0034]

Subsequently, a structure of the switching compartment of the refrigerator-freezer for carrying out the refrigerating method of Embodiment 1 of the present invention will be described referring to Figs. 8 and 10.

The switching compartment 200 is presumed to accommodate the switching case 201.

As shown in Figs. 8 and 10, a front cold-air blowout port 4 for actively feeding cold air to the front side of the switching case 201 is provided on the front side of the ceiling of the switching case 201, and a rear cold-air blowout port 5 for actively feeding cold air to the rear side of the switching case 201 is provided on the rear side of the ceiling of the switching compartment 200.

The front cold-air blowout port 4 communicates with a front damper 7 provided on the back face side of the switching compartment 200 through an air trunk 6 provided on the ceiling of the switching compartment 200. Also, the rear cold-air blowout port 5 communicates with a rear damper 9 provided on the back face side of the switching compartment 200 through an air trunk 8 provided at an upper part of the switching case 201. The front damper 7 and the damper 9 are connected to a cold-air draft trunk (not shown).

[0035]

The front cold-air blowout port 4 and the rear cold-air blowout port 5 are provided so that the cold air can be fed in a concentrated manner as shown by an arrow according to a position where the food is placed, and as shown in Fig. 10, the placed food can be rapidly cooled. At what spot in a place from the front side to the rear side the food is

placed is detected by moving the thermopile 2 provided on the front side of the ceiling of the switching compartment 200.

[0036]

As shown in Fig. 5, the thermopile 2 is installed on the front side of the ceiling of the switching compartment 200 and the thermistor 3 for detecting an air temperature in the switching chamber 200 is installed on the back face side of the switching compartment 200 since if the temperature on the front side is raised when the food is placed in the front side in the switching case 201 of the switching compartment 200 or the like, it is detected by the thermopile 2 and the front damper 7 of the front cold-air blowout port 4 is opened so as to actively feed cold air to the front side, while if the temperature on the rear side is raised, it is detected by the thermopile 2, by the thermistor 3 or by both the thermopile 2 and the thermistor 3 and the rear damper 9 of the rear cold-air blowout port 5 is opened so as to actively feed the cold air to the rear side.

[0037]

As mentioned above, since uneven temperature in the switching compartment 200 caused by placement of the food or the like can be detected by the thermopile 2 and the thermistor 3 and the cold air can be allocated, useless

overcooling in the switching compartment 200 can be prevented or the like.

Also, if the thermopile 2 is not provided, there can be a case in which, though the cooling in the switching compartment 200 is not sufficient partially, the cold air blown out from the rear cold-air blowout port 5 is shut off by the food placed on the rear side or the like and brought toward the rear side, and only the periphery of the thermistor controlling the inside temperature locally reaches a predetermined set temperature and the damper is closed, by which supply of the cold air is stopped or the like. However, if the thermopile 2 is provided in this case, since the temperature of the food placed to the front side or the like is known, and closing of the damper or stop of the cold-air supply can be prevented, and cooling performance and energy saving performance can be improved.

By realizing such distribution control of the cold air, even if the placed food is warm, it can be cooled in a concentrated manner. Thus, the temperature of the food around it is not extremely raised, which is hygienic and convenient. Even in an environment where a distance between a warm food and a frozen food is small, and the temperature of the frozen food is raised more easily, a bad influence on the foods around it can be minimized.

[0038]

In the refrigerating method proposed in the present invention, it is necessary that both the rapid cooling and supercooled refrigerating should be present, but they are contradicting cooling methods. Therefore, control needs to be switched to an environment where coexistence is possible at an appropriate timing.

In order to bring foods into a supercooled state, cooling by a cooling capacity in a certain range is needed. This means that if the cooling capacity for cooling the food is too weak or too strong, the supercooled state is not brought about or the supercooled state is cancelled soon.

[0039]

Referring to a temperature history when food is cooled, cooling capacity at temperature obviously higher than the freezing point of the food does not give a particular influence in forming a supercooled state.

However, if the temperature is higher than the freezing point of the food by several °C (2 to 3°C, for example), the cooling capacity needs to be weakened, that is, the cold-air blowout to the food surface needs to be restrained.

The freezing point is varied depending on the food, but it is in a range of 0 to -2°C for rice. In order to bring the entire food into the supercooled state, both the food surface side and the center portion needs to be brought into the supercooled state, but considering the food cooling by

blowing out low-temperature cold air, the food surface side would be frozen, first, since the cooling speed is faster there, or even though the supercooled state is achieved, the supercooling is cancelled before the center portion becomes in the supercooled state, and in this case, the center portion is frozen without going through the supercooled state or through cancellation of the supercooling in a state with a high supercooling reached temperature.

Therefore, in order to realize a stable supercooled state for the entire food, uneven temperature between the food surface side and the center portion needs to be made small, and as a method for realizing that, the cooling speed on the food surface can be suppressed, that is, the cold-air blowout to the food surface can be restrained. However, if the temperature difference between the food surface side and the center portion higher than the freezing point of the food by several °C (2 to 3°C, for example), cooling does not necessarily have to be weakened if the temperature difference between the food surface side and the center portion is within 3°C, preferably within 2°C, or more preferably within 1°C.

[0040]

Subsequently, the refrigerating method of Embodiment 1 of the present invention will be described referring to the flowchart in Fig. 11.

First, when food is placed in the front, for example, of the switching case 201 in the switching compartment 220 (Step S1) and the drawer door is closed, refrigerating control by the controller 16 is started (Step S2), a change amount of a detected temperature by the thermopile 2 is calculated (Step S3), and if the calculated detected temperature is a high temperature, which is higher than normal temperature (Step S4), the front and rear two dampers 7, 9 are opened so as to blow out cold air from the front cold-air blowout port 4 and the rear cold-air blowout port 5 and start rapid cooling (Step S5).

The normal temperature here means a usually accepted room temperature of 15 to 35°C, for example, and the high temperature refers to temperature higher than the normal temperature at 36 to 100°C, for example, whose upper limit is temperature which can be considered as foods.

A cooling speed in this rapid cooling is 0.5°C / minute or more, or more preferably 0.7°C / minute or more.

When food surface temperature as the detected temperature of the thermopile 2 becomes 40 to 1°C, preferably 25 to 3°C, or more preferably 10 to 5°C (Step S6), the rapid cooling is stopped, and supercooling is started (Step S7).

In this supercooling, the cooling capacity needs to be weakened, and in order to stop the rapid cooling at the

predetermined temperature, the controller 16, first, closes the front damper 7 and the rear damper for controlling cold-air supply into the switching compartment 220 (Step S7a) so as to stop supply of the cold air from the front and rear cold-air blowout ports 4, 5 and to weaken cooling of the food.

[0041]

With regard to a temperature at which a process to restrain supply of cold air, which is a first stage of the supercooling control so as to uniformize uneven temperature, it is only necessary that the food surface temperature is 40 to 1°C, preferably 25 to 3°C, or more preferably 10 to 5°C, and if the rapid cooling is stopped at a temperature higher than the predetermined temperature, there is no problem with the supercooled freezing, but the effect to suppress bacteria breeding, effect to suppress aging, and the effect to suppress moisture evaporation by the rapid cooling are reduced. Also, if the rapid cooling is stopped at a temperature lower than the predetermined temperature, it does not bring about the supercooled state since the food surface might be frozen, first, in the process of uniformizing the uneven temperature. Alternatively, it is highly likely that the supercooled state might become shallow, which eliminates or reduces the effect to improve freezing quality by freezing via the supercooling.

[0042]

After the supercooling is started, when the detected temperature by the thermopile 2 reaches the predetermined temperature higher than the freezing point in the vicinity of the freezing point of the food by several °C (2 to 3°C, for example) (Step S7b), the controller 16 opens the front or the rear or both the front and rear dampers 7, 9 so as to enhance the cooling capacity (Step S7c).

That is, the food peripheral temperature needs to be lowered. If the cooling capacity is too small when the freezing temperature is reached while the temperature difference between the food surface side and the center portion is still small, the supercooled state is not brought about but the freezing is realized as it is.

[0043]

Therefore, quick cooling is needed when the food temperature reaches the vicinity of the freezing point, but if a low-temperature cold air is strongly blown at this time, there is a fear that the freezing starts at the food surface from the above-mentioned factor, and attention should be paid to the cold-air temperature. Also, if the cold-air temperature after the supercooled state is brought about is too low, it is highly likely that the supercooling is cancelled, and the freezing due to continuous exposure of the food surface to the low-temperature cold air for a long

time should be prevented by setting the air temperature in the case at -15°C or more or by intermittently blowing the low-temperature cold air or the like.

Time for improving the cooling capacity at Step S7c in the supercooling is varied depending on the amount of the placed food, but it is approximately 100 to 600 minutes, and if the predetermined time has elapsed (Step S7d), the rapid cooling is started again (Step S8), and if predetermined time of 60 to 120 minutes, for example, has elapsed (Step 9), the rapid cooling is stopped and the temperature is returned to an initial set temperature of regular freezing of -7°C , for example, so as to carry out regular refrigerating (Step S10).

[0044]

As mentioned above, after the food temperature has reached a sufficiently supercooled temperature as at Step S7c, the supercooling is cancelled and freezing is started, but in this case, it is necessary to enhance the cooling capacity, that is, to actively blow out the low-temperature cold air to the food. If the cooling capacity is enhanced, not only that the supercooling is cancelled but also that the time till full freezing after the supercooling is cancelled is reduced, and ice crystal enlargement is reduced and damage to the food by the freezing is alleviated.

[0045]

When the cooling capacity is to be weakened as the supercooling at Step 7a, it is only necessary that the front and rear dampers 7, 9 are closed or time during which the dampers 7, 9 are closed is prolonged so as to suppress inflow of the cold air.

In a stage in which the cold air should not be directly blown in the case of weakening the cooling capacity in the supercooling as above, the damper close to the food placement position, that is, the damper of the blowout port at which the blown-out cold air can easily hit the food is closed, and cooling is carried out only with the cold air fed from the other blow-out port. If the low-temperature cold air needs to be actively blown to the food in the case of the rapid cooling as at Step 5, the damper close to the food placement position, that is, the damper of the blowout port at which the blown-out cold air can easily hit the food is opened or all the dampers are opened so as to feed the cold air.

[0046]

In the refrigerating method of Embodiment 1, a method of refrigerating warm foods via the supercooling after the rapid cooling is described, but even if the placed food is not warm food but cold food at normal temperature or less and unfrozen, as shown in Fig. 11, it is possible to carry out only the supercooling control by skipping the process of

the rapid cooling at Step S5.

[0047]

Embodiment 2

Fig. 12 is a perspective view illustrating a switching case of a refrigerator-freezer for carrying out the refrigerating method of Embodiment 2 of the present invention, and Fig. 13 is a perspective view illustrating another switching case of the refrigerator-freezer for carrying out the same refrigerating method.

In the above Embodiment 1, the refrigerating control proposed in the present invention is realized by the entire switching case 201 accommodated in the switching compartment 200, but in Embodiment 2, the refrigerating control proposed in the present invention is carried out only in a specific section of the switching case 201 accommodated in the switching compartment 200.

A merit obtained by carrying out the refrigerating control of the present invention only in the specific section in the switching case 201 accommodated in the switching compartment 200 is that by specifying a position where warm food is placed, a chance of contact with the frozen food can be reduced and control with higher accuracy is made possible in a narrow section.

[0048]

As shown in Fig. 12, a tray 1 to become a placement

space for food such as rice is installed on the front side of the switching case 201.

The reason why the tray 1 is provided on the front-side position of the switching case 201 as shown in Fig. 12 is that, considering that frozen foods have been already stored when warm rice is placed, for example, the rice is highly likely to be placed on the front side, and also considering that a new space is to be created for the rice, it is more convenient if the rice is placed on the uppermost stage of the case.

The tray 1 is made by aluminum or plastic, and in the case of an aluminum tray, heat conductivity is favorable and temperature distribution can become even easily, which is effective for cooling of rice.

Also, the tray 1 may have a cool-storage agent sealed, and since an effect of heat insulation can be obtained in this case, a bad influence is not given to the frozen food even if warm rice is placed for cooling with a cool-storage tray on the frozen food.

[0049]

This tray 1 has shafts 1a on the both ends, and the shafts 1a are rotatably and pivotally supported on the front side of inner faces on the both side walls of the switching case 201 and mounted rotatably on the switching case 201.

When the tray 1 is in use, a rear end on one side of

the tray 1 is placed on a rib 41 to be in a horizontal state and capable of being used. When the tray 1 is not in use, the tray 1 is rotated to a vertical state and the tray 1 is folded by hooking a recess portion (not shown) provided on the other end side of the tray 1 by a claw (not shown) provided at an upper end of a front-face opening portion of the switching case 201 so that the tray does not obstruct storage of other foods.

[0050]

Also, the tray 1 may be in a structure in which the tray is placed on the four ribs 41 provided in the switching case 201 to be stabilized as shown in Fig. 13, not in the structure capable of being folded as shown in Fig. 12.

In this case, if there are a plurality of spots where the ribs 41 are provided, layout can be changed so that the position where the tray 1 is provided can be any of the front, center, rear and the like of the switching case 201 according to a use state. Also, if the ribs 41 are to be provided, by providing a plurality of different heights in the height direction, the height of the tray 1 can be freely laid out according to amounts of existing foods and of rice to be frozen.

Also, in the structure shown in Fig. 13, the tray 1 can be stored in an upright state in a pocket 20 for tray on the front face of the switching case 201 when not in use so that

the tray does not obstruct other foods.

[0051]

Embodiments for carrying out the refrigerating method proposed in the present invention have been described using the switching compartment as an example, but the same applies to the freezing compartment.

[0052]

The refrigerating method for improving rice quality has been described, but there are cases in which the quality of other foods can be improved by freezing using this method, and the refrigerating method of the present invention should not be applied only to rice.

For example, for the food containing starch and water such as pancakes, breads and the like, results that the quality is improved by the refrigerating method of the present invention are obtained from experiments.

Therefore, use of the refrigerating method of the present invention and obtainment of the refrigerator capable of realizing the refrigerating method of the present invention have a wide range of applications in improvement of food preservative quality and a wide range of developments including industrial refrigerators can be expected.

[Brief Description of the Drawings]

[0053]

[Fig. 1] Fig. 1 is a schematic diagram illustrating a difference between a freezing method for rice in a refrigerating method for refrigerating food in Embodiment 1 of the present invention and a prior art refrigerating method for refrigerating rice.

[Fig. 2] Fig. 2 is a graph illustrating texture of rice frozen by the refrigerating method for refrigerating rice of the same refrigerating method.

[Fig. 3] Figs. 3 are graphs illustrating temperature change when water is frozen without supercooling (a) and with supercooling (b).

[Fig. 4] Fig. 4 is a side sectional view of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 5] Fig. 5 is a side sectional view showing a switching compartment of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 6] Fig. 6 is an exploded perspective view of an infrared sensor of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 7] Fig. 7 is a graph showing directivity characteristics of the infrared sensor of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 8] Fig. 8 is a side sectional view illustrating the switching compartment of the refrigerator-freezer for

carrying out the refrigerating method.

[Fig. 9] Fig. 9 is a perspective view illustrating the periphery of a sensor mounting portion of the switching compartment of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 10] Fig. 10 is a perspective view illustrating a switching case of the refrigerator-freezer for carrying out the same refrigerating method.

[Fig. 11] Fig. 11 is a flowchart illustrating an example of supercooling control of the same refrigerating method.

[Fig. 12] Fig. 12 is a perspective view illustrating a switching case of a refrigerator-freezer for carrying out the refrigerating method of Embodiment 2 of the present invention.

[Fig. 13] Fig. 13 is a perspective view illustrating another switching case of the refrigerator-freezer for carrying out the same refrigerating method.

[Reference Numerals]

[0054]

- 1: tray
- 2: thermopile
- 3: thermistor
- 4: front air blowout port
- 5: rear air blowout port
- 7: front damper

9: rear damper
10: operation panel
16: controller
100: refrigerating compartment
200: switching compartment
201: switching case
300: vegetable compartment
400: freezing compartment
500: ice-making compartment

[Name of Document] CLAIMS

[Claim 1]

A refrigerating method for refrigerating food containing starch such as rice, characterized in that

rapid cooling is conducted at a cooling speed of 0.5°C / minute or more when a food temperature is high, the rapid cooling is stopped so as to decrease a cooling capacity when a temperature on the food surface falls within a temperature range of 40 to 1°C, and when the food temperature reaches the vicinity of a freezing point temperature thereafter, the cooling capacity is raised within a range such that an air temperature around the food does not fall to -15°C or below for rapid cooling, and after rapid cooling is conducted again after a predetermined time has elapsed, regular refrigeration is conducted.

[Claim 2]

A refrigerator-freezer comprising:

a freezing compartment which can be set in a freezing temperature range and is provided with a rapid cooling function;

a case installed in the freezing compartment, for containing food;

a temperature sensor for detecting a temperature of food having a high temperature in said case;

at least two or more cold-air blowout ports for blowing

out cold air into said case; and

damper means for controlling feeding of the cold air into the cold-air blowout ports, wherein

said damper means is controlled on the basis of a detected temperature of said temperature sensor so as to carry out the refrigerating method for refrigerating food according to claim 1.

[Claim 3]

The refrigerator-freezer according to claim 2, wherein said temperature sensor is a movable-type thermopile capable of recognizing a food temperature of food placed in said case and a food placement position.

[Claim 4]

The refrigerator-freezer according to claim 2 or 3, wherein

a tray forming a space onto which food having a high temperature can be placed is detachably installed in said case.

[Claim 5]

The refrigerator-freezer according to claim 4, wherein

said tray is constituted by a member which promotes cooling of warm food or prevents transmission of heat of warm food to frozen food.