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(54) Title: A REFRIGERATOR PROVIDING SYNTHESIS OF VITAMIN D IN FOODS

(57) Abstract: The present invention relates to a refrigerator (1) comprising a body (2); at least one compartment (3) which is provided in the body (2) and which is suitable for foodstuffs containing ergosterol steroids such as mushrooms, cheese, eggs, milk, kefir, and fermented products such as bread, etc.; at least one light source (4) suitable for emitting UV-B and UV-C wavelengths, which is disposed in the compartment (3) so as to emit light onto foodstuffs; a control panel which enables the user to select the type of foodstuff for which vitamin D synthesis is desired; and a control unit (5) which, according to the type of foodstuff selected via the control panel, enables the light source (4) to first send light in the UV-C wavelength for a time predetermined by the manufacturer, and then enables the light source (4) to emit light only at the UV-B wavelength for a predetermined time by the manufacturer.



A REFRIGERATOR PROVIDING SYNTHESIS OF VITAMIN D IN FOODS

The present invention relates to a refrigerator comprising a compartment which provides maximum level of vitamin D synthesis while maintaining food quality. The present invention particularly relates to a refrigerator which provides the synthesis of vitamin D while maintaining food quality by the hybrid use of light at UVB and UVC wavelengths.

In recent years, various embodiments have been developed in refrigerators to preserve and increase the nutritional quality and freshness of vegetables, especially in the crispers. These include refrigerators with compartments using sources which emit UV light of different wavelengths or different colors. UV light sources can be used for various purposes such as sterilization, prolonging the life of vegetables with different colored light cycles, increasing nutritional values and triggering vitamin D synthesis. Vitamin D is a type of fat-soluble vitamin commonly found in the form of vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Few foodstuffs naturally contain vitamin D. Among these, oily fish (salmon, mackerel), liver, eggs, mushrooms, some cheese varieties are known as the main sources of vitamin D. As a source of vitamin D, mushrooms are also known to be the only non-animal food source available for vegans.

It is known that vitamin D2 is synthesized as a result of exposure of ergosterol, a steroid commonly found in fungi, yeasts and some cheese varieties ripened by mold, to UV light. It is also proven by some experiments that vitamin D synthesis rates are different for different wavelengths of UV light in foodstuffs containing ergosterol. The UV-C, UV-B and UV-A wavelengths have different potentials to convert the ergosterol precursor to the vitamin D form. The UV-C wavelength has the highest conversion rate, followed by the UV-B light source. UV-A has no effect on vitamin D synthesis. For mushrooms and cheese, the amount of vitamin D obtained with UV-C within the same light exposure time is two times higher than that obtained with UV-B. In both wavelengths, vitamin D synthesis shows an increasing trend depending on the application time. However, in terms of application time, it is determined that due to

the more destructive effect of UV-C, it has some negative effects on food quality, color and odor in cheese after 15 minutes and in mushrooms after 60 minutes. In other words, although UV-C light is the light source which triggers the synthesis of the highest amount of vitamin D, it causes the food to deteriorate as the application time increases. Therefore, it is impossible to obtain an effective vitamin D synthesis in foodstuffs in every long-term application with every type of UV light source.

In the state of the art European Patent Document No. EP2568237B1, a refrigerator is disclosed, comprising a compartment for synthesizing certain vitamins, such as vitamin C and D, in foodstuffs with UV light sources of different colors. Moreover, said document also discloses that UV lights trigger the synthesis of vitamin D, especially for foodstuffs such as mushrooms and cheese. However, the effect which can be obtained with the hybrid use of UV-B and UV-C light sources is not present in said document.

In the state of the art United States Patent Document No. US2018374536A1, a vitamin D synthesis system is disclosed, wherein a mushroom slurry formed by mixing mushroom pieces with a suitable liquid is passed under a UV light source on a conveyor belt. It is mentioned that the system uses only a UV-B light source which emits light in the range of 280 to 315 nm.

In another state of the art United States Patent Document No. US2016374373A1, a method is disclosed, wherein sliced fresh mushrooms are exposed to UV treatment from a UV source with wavelengths in the UV-B range, at a dose level of about 0.02 to 1.5 J/cm² and between 1-35 seconds. In said method, the UV source has a peak intensity between 310 nm and 315 nm. It is stated that in irradiated mushrooms, the content of vitamin D₂ per 84 g of mushrooms is at least 400 IU. In the application, only UV-B source is used and there is no mention of a hybrid use method with UV-C source.

The aim of the present invention is the realization of a refrigerator comprising a compartment wherein maximum vitamin D synthesis is provided without harming the food quality.

- There are a limited number of foodstuffs which contain ergosterol, a precursor for vitamin D synthesis. These are cheese varieties, fermented cheese varieties, moldy cheese varieties, leavened products such as bread, mushrooms of all kinds (culture, oyster, truffle, etc.), beer, kefir, milk, eggs and some plants such as tomatoes. For each different foodstuff, the optimum time for vitamin D synthesis before the food spoils varies. For example, in more sensitive foodstuffs such as cheese, UV-C light can be operated for a maximum of 15 minutes and UV-B light for a maximum of 30 minutes, while in less sensitive foodstuffs such as mushrooms and bread, these times can be 60 minutes for UV-C and 120 minutes for UV-B. .
- Therefore, the optimum UV-C and UV-B application time for each type of foodstuff is predetermined and stored by the manufacturer in the control unit of the refrigerator of the present invention. After the user selects the type of foodstuff, the control unit operates the UV-C and UV-B lights in a hybrid manner, sequentially, at the most appropriate times. The user can select the type of foodstuff via a screen etc. on the body or via a mobile device such as a telephone which can communicate with the control unit.

In an embodiment of the present invention, the output of rays in UV-B and UV-C wavelengths from a single UV light source can be controlled. In this embodiment, the control unit enables the light source to emit light in UV-C wavelength first for the most appropriate time determined by the manufacturer according to the foodstuff type selected by the user, and then completes the synthesis of vitamin D without spoiling the food by emitting light at UV-B wavelength.

In another preferred embodiment of the present invention, at least two light sources are mounted on the ceiling of the compartment so that there is a separate UV-B light source and a separate UV-C light source. Thus, the control unit is enabled to more easily control the lights of different wavelengths from different sources. Moreover, in this embodiment, if there is a problem in emitting light of any wavelength, it is easier for the control unit to detect the problem light source by communicating via an optical sensor etc.

The UV-C wavelength emits UV light at a wavelength in the range of 200-290 nm, and the UV-B wavelength in the range of 290-320 nm.

By means of the present invention, a refrigerator is realized, wherein vitamin D synthesis is provided on foodstuffs by exposing the steroid, which is naturally
5 contained in foodstuffs and providing vitamin D synthesis, to UV-B and UV-C rays in a hybrid manner, without spoiling the food, at optimum times.

The model embodiments related to the refrigerator realized in order to attain the aim of the present invention are shown in the attached figures, where:

Figure 1- is the perspective of the refrigerator in an embodiment of the present
10 invention.

Figure 2- is the detailed view of the compartment providing vitamin D synthesis in the refrigerator in an embodiment of the present invention.

Figure 3- is the diagram of the steps showing the operation method of the refrigerator when the selected foodstuff is mushroom/bread or cheese in an embodiment of the
15 present invention.

The elements illustrated in the figures are numbered as follows:

1. Refrigerator
2. Body
3. Compartment
- 20 4. Light source
5. Control unit
6. Reflector

T_{c1} : Target UV-C application time

T_{c2} : Target UV-B application time

25 T_{UVC} : Applied UV-C time

T_{UVB} : Applied UV-B time

The refrigerator (1) comprises a body (2); at least one compartment (3) which is provided in the body (2) and which is suitable for foodstuffs containing ergosterol steroids such as mushrooms, cheese, eggs, milk, kefir, and fermented products such as bread, etc.; and at least one light source (4) suitable for emitting UV-B and UV-C wavelengths, which is disposed in the compartment (3) so as to emit light onto foodstuffs.

The refrigerator (1) of the present invention comprises a control panel which enables the user to select the type of foodstuff for which vitamin D synthesis is desired, and a control unit (5) which, according to the type of foodstuff selected via the control panel, enables the light source (4) to first send light in the UV-C wavelength for a time predetermined by the manufacturer, and then enables the light source (4) to emit light only at the UV-B wavelength for a predetermined time by the manufacturer.

The refrigerator (1) of the present invention comprises at least one light source (4) which can be controlled to emit light at UV-B and UV-C wavelengths by the control unit (5). When the user selects the type of foodstuff placed in the compartment (3) via the control panel, the most appropriate UV-C and UV-B application times are known by the control unit (5) in advance. For example, when vitamin D synthesis is required for mushrooms and bread, UV-C application is performed for 60 minutes and UV-B application for 120 minutes. Since UV-C, which produces the most efficient vitamin D synthesis, causes foodstuffs to deteriorate faster, first light at UV-C wavelength is enabled to reach the compartment (3), then UV-C is deactivated and light at UV-B wavelength is sent into the compartment (3). Thus, while using the UV-C and UV-B wavelengths in order and in a hybrid manner, maximum vitamin D synthesis is ensured, while preventing the spoiling of the food and any threat to the health of the user.

In an embodiment of the present invention, the refrigerator (1) comprises a control unit (5) which enables the light source (4) to emit light at UV-C wavelength for a maximum of 60 minutes and at UV-B wavelength for a maximum of 120 minutes.

In an embodiment of the present invention, the refrigerator (1) comprises at least one light source (4) which emits light at UV-B wavelength and at least one light source (4)

which emits light at UV-C wavelength. In this embodiment, lights at UV-C and UV-B wavelengths are emitted by two different light sources (4). Thus, it becomes easier for the control unit (5) to control the light sources (4) and when any light source (4) malfunctions, it also becomes easier to detect which light source (4) is broken by means of an optical sensor, etc.

In an embodiment of the present invention, the refrigerator (1) comprises a reflector (6) which is disposed on the surfaces of the compartment (3) and which enables the light emitted by the light source (4) to reach the foodstuff in the compartment (3), for which vitamin D synthesis is desired, in the maximum possible manner.

10 In an embodiment of the present invention, the refrigerator (1) comprises a control unit (5) which, when the foodstuff type selected by the user is cheese, first operates the light source (4) at UV-C wavelength for up to 15 minutes, and then operates the light source (4) at the UV-B wavelength for up to 30 minutes, and turns off the same.

15 In an embodiment of the present invention, the refrigerator (1) comprises a button provided on the control panel which enables the user to activate/deactivate the vitamin D synthesis mode.

In an embodiment of the present invention, the refrigerator (1) comprises the control panel, which is a screen disposed on the body (2).

CLAIMS

1. A refrigerator (1) **comprising** a body (2); at least one compartment (3) which is provided in the body (2) and which is suitable for foodstuffs containing ergosterol steroids such as mushrooms, cheese, eggs, milk, kefir, and fermented products such as bread, etc.; and at least one light source (4) suitable for emitting UV-B and UV-C wavelengths, which is disposed in the compartment (3) so as to emit light onto foodstuffs, **characterized by** a control panel which enables the user to select the type of foodstuff for which vitamin D synthesis is desired, and a control unit (5) which, according to the type of foodstuff selected via the control panel, enables the light source (4) to first send light in the UV-C wavelength for a time predetermined by the manufacturer, and then enables the light source (4) to emit light only at the UV-B wavelength for a predetermined time by the manufacturer.
2. A refrigerator (1) as in Claim 1, **characterized by** a control unit (5) which enables the light source (4) to emit light at UV-C wavelength for a maximum of 60 minutes and at UV-B wavelength for a maximum of 120 minutes.
3. A refrigerator (1) as in Claim 1 or 2, **characterized by** comprising at least one light source (4) which emits light at UV-B wavelength and at least one light source (4) which emits light at UV-C wavelength.
4. A refrigerator (1) as in any one of Claims 1 to 3, **characterized by** a reflector (6) which is disposed on the surfaces of the compartment (3) and which enables the light emitted by the light source (4) to reach the foodstuff in the compartment (3), for which vitamin D synthesis is desired, in the maximum possible manner.
5. A refrigerator (1) as in any one of Claims 1 to 4, **characterized by** a control unit (5) which, when the foodstuff type selected by the user is cheese, first operates the light source (4) at UV-C wavelength for up to 15 minutes, and then operates the light source (4) at the UV-B wavelength for up to 30 minutes, and turns off the same.
6. A refrigerator (1) as in any one of the above claims, **characterized by** a button provided on the control panel which enables the user to activate/deactivate the vitamin D synthesis mode.

7. A refrigerator (1) as in any one of the above claims, **characterized by** the control panel, which is a screen disposed on the body (2).

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Figure 1

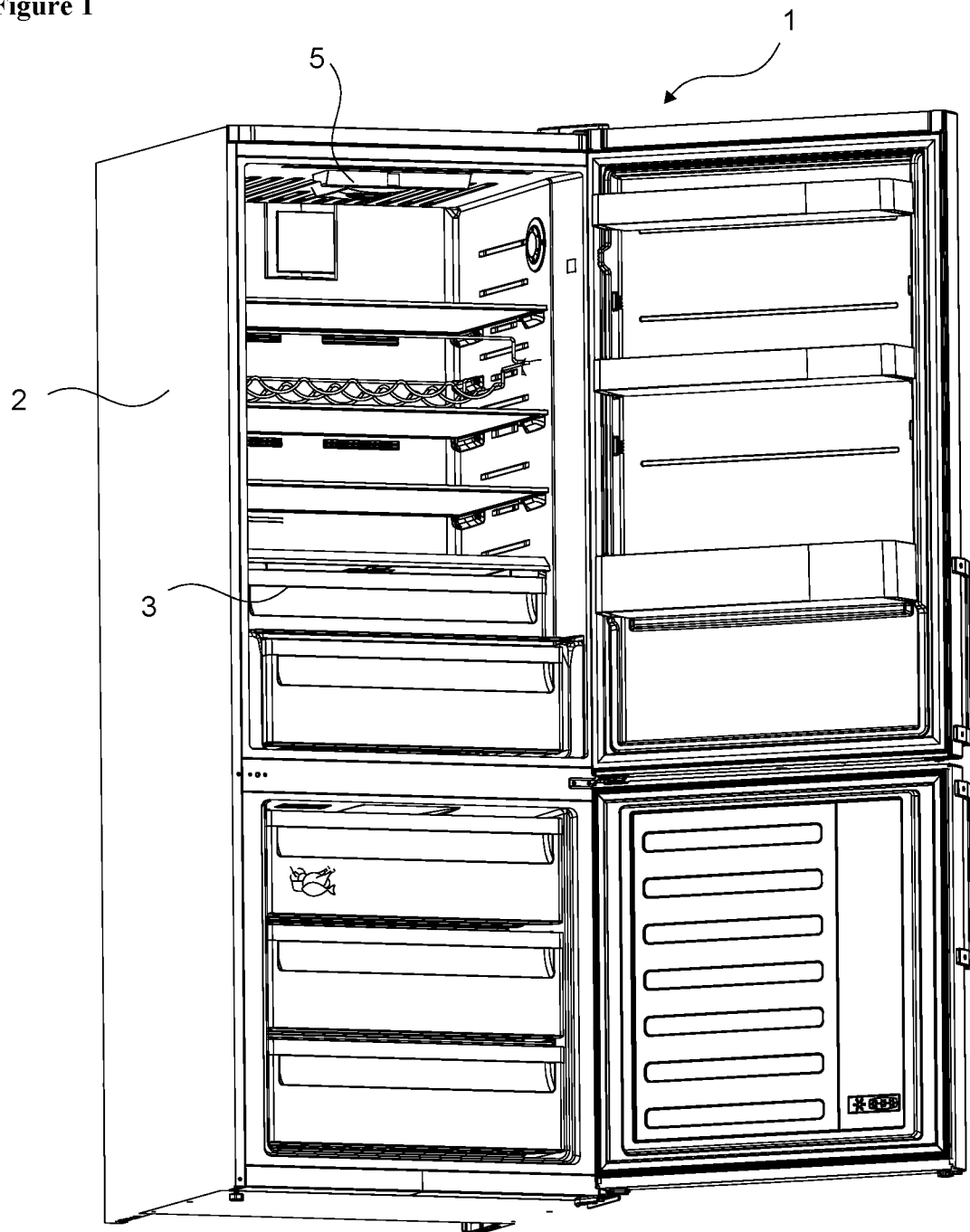


Figure 2

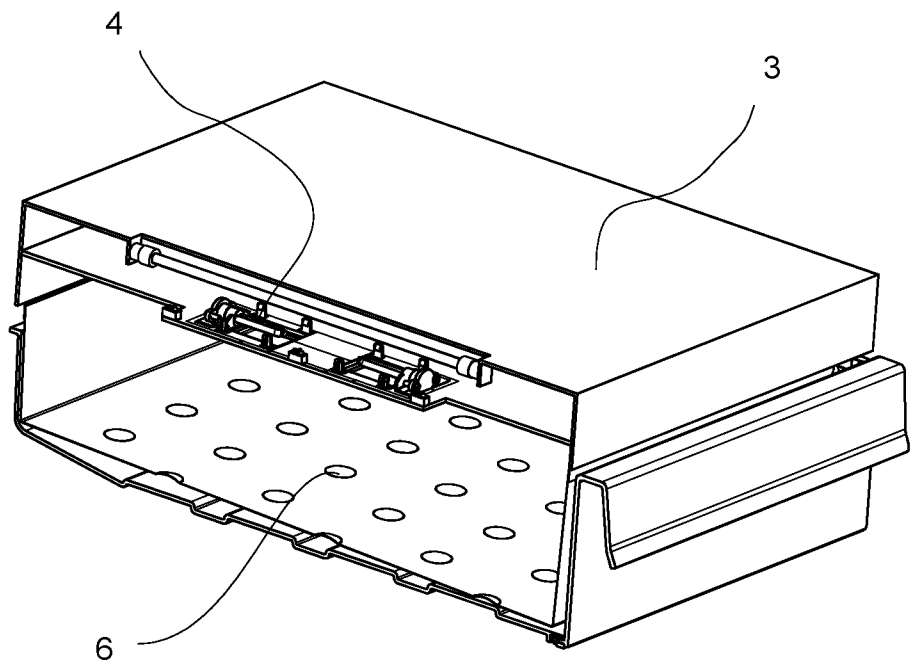
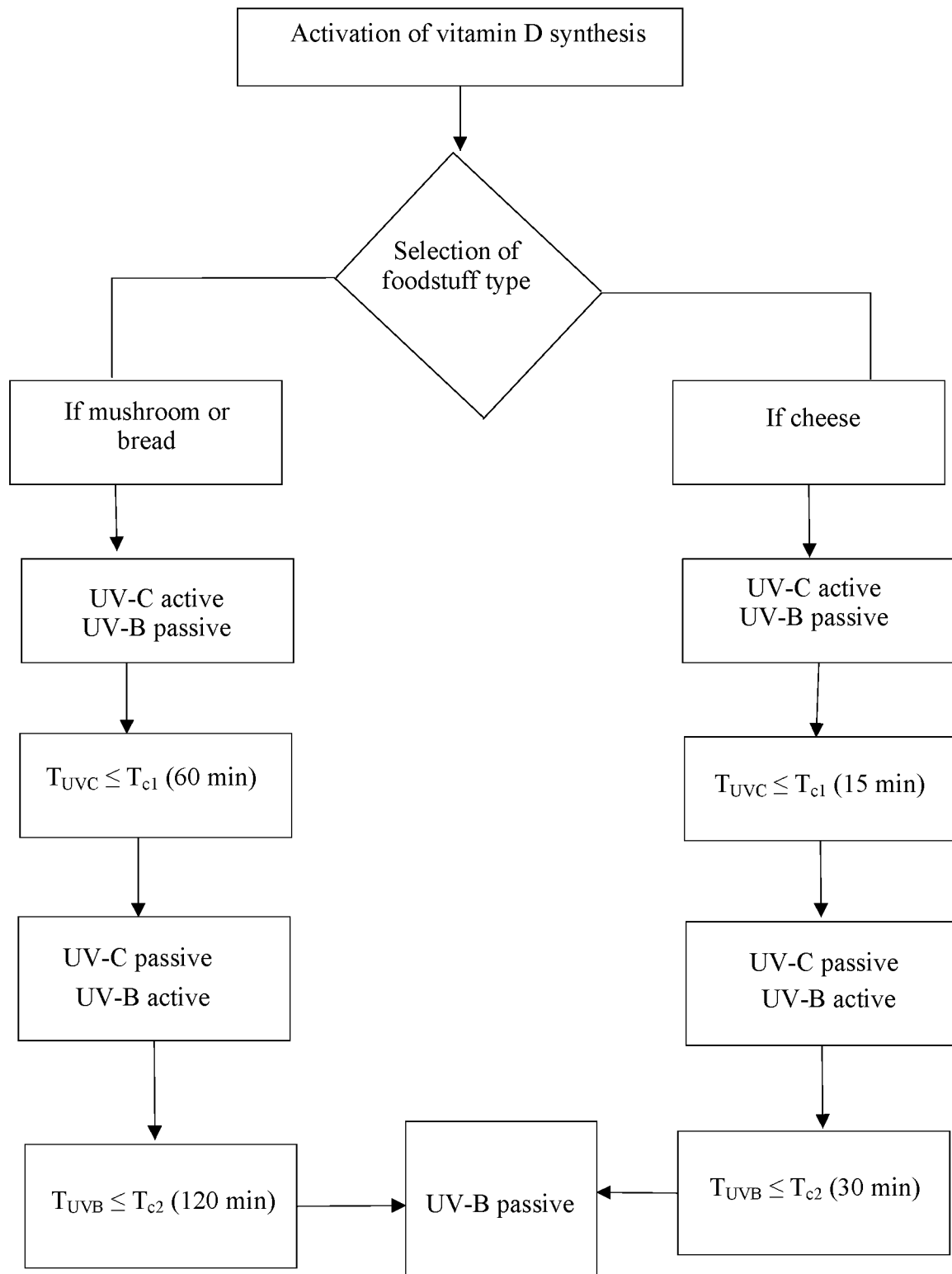


Figure 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/TR2023/050641

A. CLASSIFICATION OF SUBJECT MATTER

A23B 7/01 (2006.01)i; A23L 3/36 (2006.01)i; F25D 17/04 (2006.01)i; F25D 25/02 (2006.01)i; F25D 27/00 (2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A23B; A23L; F25D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

TURKPATENT Patent Databases

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO Abstract & Fulltext Databases, WPI Database & Keywords: refrigerator, compartment, light source, UV-B, UV-C, reflector, vitamin D

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 2568237 B1 (PANASONIC CORP [JP]) 02 August 2017 (2017-08-02) Description, especially paragraph 82	1-3, 5-7 4
Y A	US 2021289826 A1 (QU HANPENG [CN]) 23 September 2021 (2021-09-23) Description, especially paragraph 10-11, 24, 26, 28	1-3, 5-7 4



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“D” document cited by the applicant in the international application

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				WO	2020119163	A1	18 June 2020