

PATENT SPECIFICATION

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NO DRAWINGS.

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COMPLETE SPECIFICATION.

A Method of Dehydrating a Foodstuff.

I, TOZO NAKAMURA, of Japanese nationality, of No. 1018, Kugahara-machi, Ota-ku, Tokyo, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of dehydrating a foodstuff, such as fish, meat, vegetables, coffee beans and bread.

According to the present invention, there is provided a method of dehydrating a foodstuff, which comprises immersing the foodstuff in ethanol or an ethanol-water mixture which is at a temperature of -30°C . or lower thereby to cool the foodstuff and replace at least a portion of the water content of the foodstuff by ethanol, and thereafter removing the cooled unfrozen foodstuff from the ethanol or ethanol-water mixture and contacting the cooled foodstuff with a current of cold substantially dry air.

In the method of the invention, the foodstuff to be dehydrated is immersed in a non-frozen state, resulting in the replacement of some or substantially all the water content of the foodstuff by the refrigerating liquid medium, i.e. the ethanol or ethanol-water mixture, and the foodstuff is then contacted with a stream of substantially dry air which is preferably at a temperature lower than 0°C . but higher than the temperature of the foodstuff after immersion. The stream of cold dry air flows in contact with the foodstuff so that sublimation, evaporation and/or vaporization of the water and ethanol contained in the foodstuff are enhanced and promoted owing to the difference in temperature of the foodstuff and the air stream and also due to the low moisture content of the air. In the method of the invention, the foodstuff being treated does not undergo any appreciable oxidation or other chemical

change because the dehydration of the foodstuff is carried out by using a stream of dry air at a relatively low temperature.

It is preferred that the foodstuff to be dehydrated should be previously cut into slices or shredded in order to promote the replacement of the water content of the food. For example, the thickness of slices of the foodstuff can be as follows:

About 1.5 cm in the case of bean-curds (a high protein-content foodstuff made from beans).

About 1.5 cm in the case of cakes of processed fish.

About 1 cm in the case of potatoes.

About 1 cm in the case of fish or meat.

About 1.5 in the case of bread.

Small fishes such as sardines, herring, and saurels, which would usually be cooked as such, are advantageously gutted and opened before being dehydrated in accordance with the invention.

Furthermore, the other dimensions, namely length and width of the slices of the food may be varied according to the desired subsequent use, i.e. the requisites of preservation, cooking or eating. For example, these dimensions may be as follows:—

About 3 cm in length and about 2 cm in width in the case of bean-curds and cakes of processed fish.

About 10 cm in length and about 8 cm in width in the case of fish and meat.

About 15 cm in length and about 10 cm in width in the case of bread.

Some of the foodstuffs to be dehydrated initially have a considerable amount of water deposited on their surfaces, for example following a washing step with a cleaning agent or water. Particularly, bean-curds have a very large amount of water contained in their body and deposited on their surfaces. Accordingly, it is often advantageous ini-

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tially to remove superficial water or other liquid resulting in the need for a shorter duration of immersion and a reduction in consumption of refrigerating liquid.

5 The removal of water deposited on the surface of the foodstuff to be dehydrated may be carried out by any suitable manner refrigerating liquid. ~~It is preferred to con-~~
 10 ~~before the foodstuff is immersed in the refrigerating liquid.~~ It is preferred to contact the foodstuff with a stream of dry air at a relatively low temperature, e.g. $+2^{\circ}\text{C}.$ to $5^{\circ}\text{C}.$, which would neither freeze the foodstuff to be dehydrated nor result in the occur-

15 rence of oxidation or other chemical changes. When employing a mixture of ethanol and water for the immersion, an advantageous mixture is one containing about 40% by volume of water.

20 Ethanol and ethanol-water mixtures are readily evaporated, do not freeze at the temperatures employed, i.e. down to $-30^{\circ}\text{C}.$ and below, and have no effect on the foodstuff at low temperatures.

25 The duration for which the foodstuff is immersed into the refrigerating liquid can be varied depending upon the difference between the temperature of the foodstuff before its immersion and temperature of the refrigerating liquid and also depending upon
 30 the nature of this liquid. When the food to be dehydrated is at a temperature of about $+5^{\circ}\text{C}.$ and is immersed in ethanol at a temperature of about $-30^{\circ}\text{C}.$, the duration for the immersion is advantageously from
 35 3 to 5 minutes. A period of about 10 minutes may be required when a mixture of ethanol and about 40% by volume of water is employed.

40 The stream of air is passed in contact with the foodstuff and preferably in one direction and must be substantially dry. When the temperature of immersion of the foodstuff is, for example, $-30^{\circ}\text{C}.$, the temperature
 45 of the dry air stream can initially be about $-20^{\circ}\text{C}.$ and then raised to about $-5^{\circ}\text{C}.$ Alternatively, the temperature of the dry air stream can be about $-5^{\circ}\text{C}.$ from the beginning.

50 In order to carry out a more complete removal of the liquid from the foodstuff, it is possible to effect a final drying step employing a stream of dry air at a temperature of about $+3^{\circ}\text{C}.$ for a short period of time.

55 The duration for which the stream of dry air should be passed in contact with the foodstuff varies depending on the nature of the foodstuff and on the nature of the refrigerating liquid employed. When pure ethanol is used at a temperature of $-30^{\circ}\text{C}.$, a stream of dry air at a temperature of about $-20^{\circ}\text{C}.$ may first be passed in contact with the foodstuff for about 1 hour and subsequently a stream of dry air at a temperature
 65 of about $-5^{\circ}\text{C}.$ may be passed in contact

with the foodstuff for about 1 hour. When a stream of dry air at a temperature of $-5^{\circ}\text{C}.$ is passed in contact with the foodstuff from the beginning, the duration for the passage of this dry air stream may conveniently be about 2 hours. Finally, the stream of dry air at about $+3^{\circ}\text{C}.$ may be passed generally for about 5 minutes in order to complete the removal of the retained liquid as described above. The velocity of the dry air stream is preferably as high as possible, within the limit that the pieces of foodstuff are not scattered.

The duration of passage of the dry air stream may, of course, be prolonged, if necessary.

The final passage of a stream of dry air at a temperature of about $+3^{\circ}\text{C}.$ is a so-called "finishing" dehydration step. The quantities of water and ethanol removed from the foodstuff during this finishing dehydration step are, of course, small compared with the total quantities removed in the overall process. Therefore, a vacuum pump may be employed to carry out the finishing dehydration step in place of the dry air treatment at $+3^{\circ}\text{C}.$

In general, the ingredients of the foodstuff, such as proteins, fats, various vitamins (C, B₁, B₂, A) and mineral components do not undergo changes when they are kept at a low temperature.

Since the present invention permits foodstuffs to be dehydrated at low temperatures, the above-mentioned ingredients of the foodstuff do not undergo changes and various satisfactorily dehydrated products can be produced, for example, from raw vegetables, raw fish and meat, and freshly cooked fish and meat.

The products produced according to the method of the present invention are hygroscopic in nature, and would be liable to be decomposed if they were allowed to absorb moisture from the air or be contaminated with fungi and/or bacteria. For this reason, the products should be preserved under sterile air-free conditions.

WHAT I CLAIM IS:

1. A method of dehydrating a foodstuff, which comprises immersing the foodstuff in ethanol or an ethanol-water mixture which is at a temperature of $-30^{\circ}\text{C}.$ or lower thereby to cool the foodstuff and replace at least a portion of the water content of the foodstuff by ethanol, and thereafter removing the cooled unfrozen foodstuff from the ethanol or ethanol-water mixture and contacting the cooled foodstuff with a current of cold substantially dry air.

2. A method according to Claim 1, wherein the foodstuff is sliced or shredded prior to immersion.

3. A method according to Claim 1 or 2,



5 tially to remove superficial water or other liquid resulting in the need for a shorter duration of immersion and a reduction in consumption of refrigerating liquid.

10 The removal of water deposited on the surface of the foodstuff to be dehydrated may be carried out by any suitable manner refrigerating liquid. ~~It is preferred to con-~~
~~before the foodstuff is immersed in the~~
~~refrigerating liquid.~~ It is preferred to contact the foodstuff with a stream of dry air at a relatively low temperature, e.g. +2°C. to 5°C., which would neither freeze the foodstuff to be dehydrated nor result in the occur-
 15 rence of oxidation or other chemical changes.

When employing a mixture of ethanol and water for the immersion, an advantageous mixture is one containing about 40% by volume of water.

20 Ethanol and ethanol-water mixtures are readily evaporated, do not freeze at the temperatures employed, i.e. down to -30°C. and below, and have no effect on the foodstuff at low temperatures.

25 The duration for which the foodstuff is immersed into the refrigerating liquid can be varied depending upon the difference between the temperature of the foodstuff before its immersion and temperature of the refrigerating liquid and also depending upon the nature of this liquid. When the food to be dehydrated is at a temperature of about +5°C. and is immersed in ethanol at a temperature of about -30°C., the duration for the immersion is advantageously from 3 to 5 minutes. A period of about 10 minutes may be required when a mixture of ethanol and about 40% by volume of water is employed.
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40 The stream of air is passed in contact with the foodstuff and preferably in one direction and must be substantially dry. When the temperature of immersion of the foodstuff is, for example, -30°C., the temperature of the dry air stream can initially be about -20°C. and then raised to about -5°C. Alternatively, the temperature of the dry air stream can be about -5°C. from the beginning.
 45

50 In order to carry out a more complete removal of the liquid from the foodstuff, it is possible to effect a final drying step employing a stream of dry air at a temperature of about +3°C. for a short period of time.

55 The duration for which the stream of dry air should be passed in contact with the foodstuff varies depending on the nature of the foodstuff and on the nature of the refrigerating liquid employed. When pure ethanol is used at a temperature of -30°C., a stream of dry air at a temperature of about -20°C. may first be passed in contact with the foodstuff for about 1 hour and subsequently a stream of dry air at a temperature
 60 of about -5°C. may be passed in contact
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with the foodstuff for about 1 hour. When a stream of dry air at a temperature of -5°C. is passed in contact with the foodstuff from the beginning, the duration for the passage of this dry air stream may conveniently be about 2 hours. Finally, the stream of dry air at about +3°C. may be passed generally for about 5 minutes in order to complete the removal of the retained liquid as described above. The velocity of the dry air stream is preferably as high as possible, within the limit that the pieces of foodstuff are not scattered.
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The duration of passage of the dry air stream may, of course, be prolonged, if necessary.
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The final passage of a stream of dry air at a temperature of about +3°C. is a so-called "finishing" dehydration step. The quantities of water and ethanol removed from the foodstuff during this finishing dehydration step are, of course, small compared with the total quantities removed in the overall process. Therefore, a vacuum pump may be employed to carry out the finishing dehydration step in place of the dry air treatment at +3°C.
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In general, the ingredients of the foodstuff, such as proteins, fats, various vitamins (C, B₁, B₂, A) and mineral components do not undergo changes when they are kept at a low temperature.
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Since the present invention permits foodstuffs to be dehydrated at low temperatures, the above-mentioned ingredients of the foodstuff do not undergo changes and various satisfactorily dehydrated products can be produced, for example, from raw vegetables, raw fish and meat, and freshly cooked fish and meat.
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 105

The products produced according to the method of the present invention are hygroscopic in nature, and would be liable to be decomposed if they were allowed to absorb moisture from the air or be contaminated with fungi and/or bacteria. For this reason, the products should be preserved under sterile air-free conditions.
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WHAT I CLAIM IS:

1. A method of dehydrating a foodstuff, which comprises immersing the foodstuff in ethanol or an ethanol-water mixture which is at a temperature of -30°C. or lower thereby to cool the foodstuff and replace at least a portion of the water content of the foodstuff by ethanol, and thereafter removing the cooled unfrozen foodstuff from the ethanol or ethanol-water mixture and contacting the cooled foodstuff with a current of cold substantially dry air.
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2. A method according to Claim 1, wherein the foodstuff is sliced or shredded prior to immersion.

3. A method according to Claim 1 or 2,



wherein the foodstuff is preliminarily dried before immersion to remove superficial water.

5 4. A method according to any preceding claim, wherein the current of air is maintained at a temperature above that of the cooled foodstuff but below 0°C. and the current of air is supplied for about two hours.

10 5. A method according to Claim 4, wherein the cooled foodstuff is contacted with the current of air in two stages, the temperature of the air in the first stage being below that in the second stage.

15 6. A method according to Claim 5, wherein the air temperature in the first stage is about -20°C. and in the second stage is about -5°C.

20 7. A method according to Claim 5 or 6, wherein the duration of each stage is about one hour.

8. A method according to any preceding claim wherein the immersion is effected for a period of from three to ten minutes.

25 9. A method according to Claim 3 or any of Claims 4 to 8 as appendant to Claim 3, wherein the preliminary drying is effected by contact with substantially dry air at a temperature of from 2 to 5°C. for a period
30 of about five minutes.

10. A method according to any preceding claim, wherein the foodstuff is first cleaned with a cleaning agent.

11. A method according to any preceding claim, wherein residual ethanol remaining after the treatment with cold air is removed by subjecting the foodstuff to a degree of vacuum. 35

12. A method according to any preceding claim, wherein an ethanol-water mixture is employed containing about 40% by volume of water. 40

13. A method according to any preceding claim, wherein the foodstuff is meat, fish, vegetable, coffee beans or bread. 45

14. A method according to Claim 1 of dehydrating a foodstuff, substantially as hereinbefore described.

15. Dehydrated foodstuff whenever produced by the method claimed in any preceding claim. 50

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