is preferably at least one of retinol, α-carotene, β-carotene, β-cryptoxanthin, vitamin D, α-tocopherol, vitamin K, vitamin B1, vitamin B2, niacin, vitamin B6, vitamin B12, folic acid, pantothenic acid, biotin, vitamin C, an n-3 polyunsaturated fatty acid, or an n-6 polyunsaturated fatty acid.

[0012] According to such a configuration, it is possible to observe an attenuation trend in a short period of time even for a nutrient whose attenuation is less likely to be observed.

ADVANTAGEOUS EFFECTS OF INVENTION

[0013] The present invention achieves checking nutrient attenuation in a frozen food by using an accelerated test, which could not be conventionally used for frozen foods. Accordingly, since the nutrient attenuation can be checked without requiring the usual lapse of time, products can be designed without being subject to limitation on cooking methods.

BRIEF DESCRIPTION OF DRAWINGS

[0014] FIG. 1 shows attenuation of vitamin D, α-tocopherol, vitamin K, and vitamin B1 when a frozen food (dan dan noodles) has been subjected to an accelerated test in the present invention and a test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 2 shows attenuation of vitamin B2, vitamin B6, vitamin B12, and folic acid when a frozen food (dan dan noodles) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 3 shows attenuation of pantothenic acid, biotin, an n-3 polyunsaturated fatty acid, and an n-6 polyunsaturated fatty acid when a frozen food (dan dan noodles) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 4 shows attenuation of vitamin C when a frozen food (dan dan noodles) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 5 shows attenuation of vitamin D, vitamin K, vitamin B1, and vitamin B2 when a frozen food (beef rice bowl) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 6 shows attenuation of vitamin B6, vitamin B12, folic acid, and pantothenic acid when a frozen food (beef rice bowl) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 7 shows attenuation of biotin and vitamin C when a frozen food (beef rice bowl) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 8 shows attenuation of vitamin D, vitamin B1, vitamin B2, and vitamin B6 when a frozen food (curry) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 9 shows attenuation of vitamin B12, folic acid, pantothenic acid, and biotin when a frozen food (curry) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 10 shows attenuation of vitamin C when a frozen food (curry) has been subjected to the accelerated test in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

FIG. 11 shows attenuation of vitamin D, folic acid, and vitamin C when a frozen food (curry) has been subjected to the accelerated test (400 MPa) in the present invention and the test in the related art. The vertical axis represents a relative value with a measured value of a nutrient before a storage test being 100, and the horizontal axis represents the number of days.

preferably 100°C.

[0020] A humidity condition in the present invention is not limited.

[0021] In the present invention, a test apparatus is preferably capable of heating while maintaining a pressurized condition. By way of example, an apparatus manufactured by Toyo Koatsu Inc., may be used. Using such an apparatus, the temperature condition can be changed while the pressure condition is kept constant.

[0022] As an accelerated test method, a plurality of same samples is prepared and heated under pressurized conditions, as in an existing method. At predetermined time intervals (e.g., monthly), only one of the plurality of samples may be taken out, and the nutrient content may be measured. The existing method may be used to analyze the nutrient content. For example, methods such as high performance liquid chromatography (HPLC), a microbiological assay, liquid chromatography-tandem mass spectrometry (LC-MS/MS), and gas chromatography can be used.

EXAMPLES

[0023] <Checking of Microorganism Growth at Room Temperature by Pressurization>

First, the effect of growth inhibition of microorganisms by pressurization was checked. A commercially available frozen food (chicken in tomato sauce: manufactured by NISSIN FOOD PRODUCTS CO., LTD.) was placed into an apparatus manufactured by Toyo Koatsu Inc. and subjected to a test. The test conditions at this time were a temperature of 25°C, a pressure of 100 MPa, 40 MPa, or 10 MPa, followed by standing for 5 days. After 5 days, the presence of the microorganism was checked by using a known test method. The results are shown in Table 1.

[0024] [Table 1]

	Microorganism		
	Common bacteria (cfu/g)	Fungi (molds, yeast) (cfu/g)	E. coli (cfu/g)
10 MPa	1.0×10^7	4.0×10^1	2.3×10^4
40 MPa	n.d.	n.d.	n.d.
100 MPa	n.d	n.d	n.d

[0025] As is clear from Table 1, by applying a pressure of 40 MPa or more, the effect of growth inhibition of microorganisms was observed.

[0026] <Checking of Nutrient Attenuation>

Next, the nutrient attenuation was checked. The checking test was performed by

measuring and comparing amounts of the nutrient contained in products stored under different conditions. The test conditions are as follows.

[0027] <<Frozen Storage>>

For the checking of the nutrient attenuation by frozen storage, the sample was placed in a normal pressure environment at -20°C and the nutrient attenuation was checked after 6 months and 12 months.

[0028] <<Pressurized High Temperature Storage>>

For the checking of the nutrient attenuation by pressurized high temperature storage, the sample was placed in an environment of 50°C and 90 MPa, and the nutrient attenuation was checked after 2 weeks and 4 weeks.

[0029] In the present example, under each test condition, samples of the same lot were used, and the test was performed on three types of products (KANZEN MESHI dan dan noodles, KANZEN MESHI beef rice bowl, and KANZEN MESHI European-style curry, all manufactured by NISSIN FOOD PRODUCTS CO., LTD.).

[0030] For each sample before the storage test and after the storage test, amounts of the nutrient contained in the product were measured. The amounts of vitamin B1, vitamin B2, vitamin C, α-tocopherol, and vitamin K were measured by an HPLC method. The amounts of vitamin B6, vitamin B12, biotin, pantothenic acid, and folic acid were measured by a microbiological assay. The amount of vitamin D was measured by using liquid chromatography-tandem mass spectrometry. The amounts of the n-3 polyunsaturated fatty acid and the n-6 polyunsaturated fatty acid were measured by gas chromatography.

An approximation equation was determined based on the obtained measured values, and a slope of the approximation equation in each nutrient was determined. The results are shown in FIGs. 1 to 10. The vertical axis represents a relative value with the measured value of the nutrient before the storage test being 100, and the horizontal axis represents the number of days.

[0031] As shown in FIGs. 1 to 10, there was a difference in slope of the approximation equation for each sample and/or each nutrient. In addition, it has been found that although there were some exceptions, in almost all of the storage methods (pressurized high temperature storage) according to the present invention, the slope was steeper than that of a method in the related art (frozen storage). On the other hand, although not shown in the drawing, there were some cases where the slope is substantially the same as that of the method in the related art, or in some cases the slope increases. Here, since foods deteriorate over time, typically, the amount

was observed most easily for curry. The magnitude of the slope was as follows: curry > dan dan noodles > beef rice bowl. Here, when the case of dan dan noodles is described as an example, it was found that 1 month in the pressurized high temperature storage method corresponds to about 12 months in the method in the related art.

[0040] "Folic Acid"

Referring to FIGs. 2, 6, and 9, it has been found that in the method in the related art, almost no attenuation was observed in any sample, and the line was almost horizontal. In contrast, in the pressurized high temperature storage, the magnitude of the slope was as follows: dan dan noodles ≈ curry > beef rice bowl, and the attenuation promotion effect was easily found.

[0041] "Pantothenic Acid"

Referring to FIGs. 3, 6, and 9, in the method in the related art, the result showed a slight upward trend in any sample, and no attenuation was observed. In contrast, in the pressurized high temperature storage, the magnitude of the slope was as follows: curry > beef rice bowl > dan dan noodles, and the attenuation promotion effect was easily found.

[0042] "Biotin"

Referring to FIGs. 3, 7, and 9, in the method in the related art, the slope increased in the order of dan dan noodles, beef rice bowl, and curry. On the other hand, in the pressurized high temperature storage, the magnitude of the slope was as follows: beef rice bowl > curry. However, no attenuation was observed in the dan dan noodles and the line was almost horizontal. Here, when the case of beef rice bowl is described as an example, it was found that 1 month in the pressurized high temperature storage method corresponds to about 12 months in the method in the related art. In addition, in the case of curry, it was found that 1 month in the pressurized high temperature storage method corresponds to about 290 days in the method in the related art.

[0043] "n-3 Polyunsaturated Fatty Acid" and "n-6 Polyunsaturated Fatty Acid"

For an n-3 polyunsaturated fatty acid and an n-6 polyunsaturated fatty acid, the result for only the dan dan noodles (FIG. 3) was shown. In the method in the related art, the line was almost horizontal, whereas in the pressurized high temperature storage, attenuation was observed, and the attenuation promotion effect was easily found. In addition, in the n-3 polyunsaturated fatty acid and the n-6 polyunsaturated fatty acid, the attenuation of the n-3 polyunsaturated fatty acid was faster.

[0044] "Vitamin C"

For vitamin C, in the method in the related art, attenuation was observed in dan dan noodles (FIG. 4) and curry (FIG. 10), but no attenuation was observed in beef rice bowl (FIG. 7) and the line was almost horizontal. On the other hand, in the pressurized high temperature