

DESCRIPTION

TITLE OF INVENTION: METHOD FOR CONFIRMING NUTRIENT ATTENUATION OF FROZEN FOOD

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TECHNICAL FIELD

[0001] The present invention relates to a method for checking nutrient attenuation in a frozen food.

10 BACKGROUND ART

[0002] In recent years, due to diversification of lifestyle, a product called an optimized nutritional diet, which is stated to enable easy intake of necessary nutrients in one day, has been put on the market. The product contains one-third or more of the amount of essential nutrients required per day described in Nutrient Reference Values for labeling established by the Ministry of Health, Labour and Welfare of Japan and the dietary reference intakes for Japanese formulated by the Ministry of Health, Labour and Welfare of Japan. Aside from this, there are also products such as semi-complete diets which lack only a few types of nutrients but are almost complete diets, and supplements that supplement only specific nutrients, and a wide variety of foods that can easily supplement necessary nutrients that are insufficient in daily diets are on the market.

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CITATION LIST

PATENT LITERATURE

[0003] Patent Literature 1: JP-2003-274894A

25 [0004] Incidentally, some nutrients contained in foods, not limited to the optimized nutritional diet, are attenuated over time. Therefore, in a product that is stated to enable intake of necessary nutrients, the nutrients need to be within the range of the dietary reference intakes for Japanese (2020) defined by the Ministry of Health, Labour and Welfare of Japan at the time of production and within the best-before period.

30 [0005] One desirable method of measuring nutrient attenuation is to sequentially measure the attenuation over time. However, this method has a problem that it takes a long time to obtain the desired result. Therefore, measurement is basically performed using an accelerated test. Here, the accelerated test is a method of shortening a test period by changing a test environment.

Specifically, the accelerated test is performed by storing in an environment in which the temperature, humidity, or the like is higher than a distribution/sales/storage temperature.

[0006] The accelerated test is a very efficient test method for foods stored at room temperature. On the other hand, for chilled foods or frozen foods, the accelerated test is difficult to use in practice. In particular, frozen foods are required to be stored at a temperature of -15°C or lower. When the temperature is increased to -15°C or higher, bacteria may proliferate, and the test itself can no longer be properly conducted. Therefore, an accelerated test method for frozen foods has not been established at present.

10 SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] An object of the present invention is to provide a method capable of efficiently measuring nutrient attenuation in a frozen food without proliferation of bacteria or the like even when the frozen food is placed in a temperature environment higher than a distribution/sales/storage temperature.

SOLUTION TO PROBLEM

[0008] The inventors of the present invention have conducted intensive studies to solve the above problems. Then, the inventors of the present invention have newly found that increasing the temperature of a frozen food while the frozen food is placed in a high pressure environment allows for checking an attenuation change of a nutrient contained in the frozen food in a shorter time than before along with suppressing proliferation of bacteria, and have completed the present invention.

[0009] In order to solve the above problems, a method for checking nutrient attenuation in a frozen food according to the present invention includes a step of performing an accelerated test on a frozen food at a temperature of 0°C or higher and under a high pressure condition of 90 MPa or more, and a step of analyzing a nutrient contained in the frozen food subjected to the accelerated test.

[0010] According to such a configuration, it is possible to examine nutrient attenuation in a short period of time by performing heating while preventing proliferation of bacteria by setting a high pressure condition.

[0011] In the above configuration, the condition in the accelerated test is preferably 10°C to 60°C and a high pressure condition of 90 MPa to 600 MPa. Further, the nutrient to be checked

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.

- 5 [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

- 10 [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

- 15 [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 an accelerated 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.

- 20 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 accelerated 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.

- 25 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 accelerated 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.

- 30 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 accelerated 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 accelerated 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 accelerated 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 accelerated 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 accelerated 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 accelerated 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 accelerated 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 accelerated 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.

DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, the present invention will be described in detail. However, the present invention is not limited to the following description.

5 [0016] <Frozen Food>

The frozen food usable in the present invention is not particularly limited, and any commercially available frozen food may be used. Examples of the frozen food include, in terms of form, processed foods such as cooked rice, noodles, filled foods, pizza, gratin, prepared foods, soups, and desserts, and unprocessed foods such as cut vegetables and fruits.

10 Any heating cooking method (natural thawing, microwave heating, hot water heating, or the like) may be used for eating.

[0017] <Nutrient>

A target nutrient in the present invention is preferably a nutrient known to attenuate over time as a single nutrient. Specific examples thereof include 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, and an n-6 polyunsaturated fatty acid. In the present invention, not only a single nutrient but also a plurality of nutrients can be checked.

[0018] <Pressurization>

20 The present invention is characterized by the use of high pressure. As used herein, the term “high pressure” refers to a pressure of 90 MPa or more, and preferably 100 MPa or more. When the pressure is less than 90 MPa, bacteria may proliferate, which is not preferred. On the other hand, when the pressure exceeds 600 MPa, the types of frozen-food samples and capacities are extremely limited. Accordingly, the pressure is preferably 600 MPa or less, and
25 more preferably 400 MPa or less.

[0019] <Accelerated test>

In the present invention, an accelerated test is preferably performed at a temperature of 0°C or higher, which is higher than -15°C as a distribution/sales/storage temperature of frozen foods. Specifically, the temperature is preferably room temperature (23°C) or higher, 30 more preferably 40°C or higher, and still more preferably 50°C or higher. Among them, the temperature is preferably 50°C or higher in order to examine nutrient attenuation in a short period of time. On the other hand, the upper limit of the temperature is not limited, but is

preferably 100°C or lower.

[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
5 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
10 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.).

15 [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
20 chromatography-tandem mass spectrometry. The amounts of the n-3 unsaturated fatty acid and
the n-6 unsaturated 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
25 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
30 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

of the nutrient contained in the food is also usually reduced. However, the nutrient is also a substance that tends to cause an error in the measurement, as described in various papers (for example, Vitamins, 85(12), 645-650 (2010), Determination of Vitamin D in Foods by the Official Method in Japan and Its Modified Method: Interlaboratory Studies, and Vitamins, 73(11), 649-657 (1999), Analytical Methods for the Determination of Vitamins in Foods Adopted and Recommended in Japan). Therefore, in the present Example, the data were regarded as valid unless the slope was more than +1.1. Note that, the present invention is naturally applicable to nutrients not shown in FIGs. 1 to 10.

[0032] Next, when FIGs. 1 to 4, FIGs. 5 to 7, and FIGs. 8 to 10 are compared, it can be seen that there is a difference in attenuation even with the same nutrient. It is considered that this is because the difference in nutrient attenuation depends on the cooking method. In this manner, it can be said that the present invention is very effective even in the case where the nutrient attenuation differs depending on the sample.

[0033] Next, the nutrient attenuation will be further examined.

"Vitamin D"

Referring to FIGs. 1, 5, and 8, it has been found that in the test method by usual frozen storage (indicated by "Related art" in the drawing, the same applies hereinafter), almost no attenuation was observed in any sample, and the line was almost horizontal. In contrast, in the test method by pressurized high temperature storage (indicated by "Present invention" in the drawing, the same applies hereinafter), the nutrient attenuation was observed in any sample. Among them, the slopes for dan dan noodles (FIG. 1) and curry (FIG. 8) were substantially the same. On the other hand, the slope for beef rice bowl (FIG. 5) was gentler than those of the other two samples, but an attenuation promotion was easily observed in any sample.

" α -Tocopherol"

For α -tocopherol, an error was likely to occur in the measurement, and the result for only dan dan noodles (FIG. 1) was shown. The line was almost horizontal in the method in the related art, whereas attenuation was observed in the pressurized high temperature storage.

"Vitamin K"

Vitamin K was checked in dan dan noodles (FIG. 1) and beef rice bowl (FIG. 5). In the method in the related art, the result showed a slight upward trend in all foods, but this is considered to be within the range of error. Therefore, this suggests that vitamin K is less likely to attenuate. On the other hand, attenuation was observed in the pressurized high temperature storage. Among them, it can be seen that the slope for dan dan noodles was steep, which was

about twice the slope of beef rice bowl. In any sample, the attenuation promotion effect was easily found.

[0036] "Vitamin B1"

Referring to FIGs. 1, 5, and 8, in the method in the related art, the result showed a slight upward trend in any sample, but this is considered to be within the range of error. Therefore, this suggests that vitamin B1 is less likely to attenuate. On the other hand, in the pressurized high temperature storage, attenuation was observed in any sample. The magnitude of the slope was as follows: dan dan noodles (FIG. 1) > beef rice bowl (FIG. 5) $\approx$ curry (FIG. 8). In any sample, the attenuation promotion effect was easily found.

[0037] "Vitamin B2"

Referring to FIGs. 2, 5, and 8, attenuation was observed in both the method in the related art and the pressurized high temperature storage. In the method in the related art, the slope increased in the order of dan dan noodles, beef rice bowl, and curry (the degree of slope decreased by 1/2). On the other hand, in the pressurized high temperature storage, the slope was as follows: beef rice bowl > dan dan noodles $\approx$ curry. In any sample, the attenuation promotion effect was easily found. 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 corresponds to about 7 months in the method in the related art.

[0038] "Vitamin B6"

For vitamin B6, in the method in the related art, attenuation was only observed in dan dan noodles (FIG. 2), and no attenuation was observed in beef rice bowl (FIG. 6) and curry (FIG. 8), and the line was almost horizontal. In contrast, in the pressurized high temperature storage, attenuation was observed in any sample. In the method in the related art, the slope increased in the order of dan dan noodles, beef rice bowl, and curry (the degree of slope decreased by 1/2). On the other hand, in the pressurized high temperature storage, the slope was as follows: beef rice bowl > dan dan noodles $\approx$ curry. 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.

[0039] "Vitamin B12"

For vitamin B12, in the method in the related art, slight attenuation was only observed in dan dan noodles (FIG. 2), and no attenuation was observed in beef rice bowl (FIG. 6) and curry (FIG. 9), and the line was almost horizontal. In contrast, in the pressurized high temperature storage, attenuation was observed in any sample. Among them, attenuation effect

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.

5 [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 $\approx$ curry > beef rice bowl, and the attenuation promotion effect was easily found.

10 [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.

15 [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.

20 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 Acid" and "n-6 Polyunsaturated Acid"

25 For an n-3 polyunsaturated acid and an n-6 polyunsaturated 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 acid and the n-6 polyunsaturated acid, the attenuation of the n-3 polyunsaturated acid was faster.

30 [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

storage, attenuation was observed in any sample. The magnitude of the slope was as follows: curry > beef rice bowl > dan dan noodles. Here, when the case of curry is described as an example, it was found that 1 month in the pressurized high temperature storage method corresponds to about 400 days in the method in the related art. In any sample, the attenuation promotion effect was easily found.

[0045] Next, the sample was placed in an environment of 50°C and 400 MPa, and the nutrient attenuation was checked after 1 week to 4 weeks. In the present example, samples of the same lot were used, and the test was performed on KANZEN MESHI European-style curry (manufactured by NISSIN FOOD PRODUCTS CO., LTD.).

[0046] For each sample before the storage test and after the storage test, amounts of nutrients contained in the product were measured. The amount of vitamin D was measured by liquid chromatography-tandem mass spectrometry. The amount of vitamin C was measured by an HPLC method. The amount of folic acid was measured by a microbiological assay. An approximation equation was determined based on the obtained measured values, and a slope of the approximation equation in each nutrient was determined. Here, nutrients in which the higher attenuation promotion effect was found than that in the case of 90 MPa described above were shown in FIG. 11.

[0047] "Vitamin D"

Comparing FIG. 8 and FIG. 11, it was found that the slope of the approximate line increased by about 23% at 400 MPa compared to 90 MPa. That is, this suggests that, for vitamin D, the attenuation was promoted by heating and the attenuation promotion effect was further obtained by applying a high pressure.

[0048] "Folic Acid"

Comparing FIG. 9 and FIG. 11, it was found that the slope of the approximate line increased by about 36% at 400 MPa compared to 90 MPa. That is, this suggests that, for folic acid, the attenuation was promoted by heating and the attenuation promotion effect was further obtained by applying a high pressure.

[0049] "Vitamin C"

Comparing FIG. 10 and FIG. 11, it was found that the slope of the approximate line increased by about 660% at 400 MPa compared to 90 MPa. That is, this suggests that, for vitamin C, the attenuation was promoted by heating and the attenuation promotion effect was further obtained by applying a high pressure. Actually, it was found that, at 90 MPa, it took 4 weeks to achieve -20% attenuation, whereas, at 400 MPa, it took 1 week to achieve -60%

attenuation due to the attenuation promotion effect by pressure.

[0050] No rot due to microorganism growth was observed during any test.

[0051] As described above, the present invention allows for checking, in a short time, the nutrient attenuation in the frozen food, which was possible in the related art only under limited conditions in order to prevent proliferation of bacteria. Further, by setting a high pressure, it is possible to combine the attenuation promotion effect by heating and the attenuation promotion effect by a high pressure, so that the nutrient attenuation can be checked in a shorter time. Accordingly, the present invention exhibits an extremely excellent effect that the products can be designed without being subject to limitation on cooking methods.

CLAIMS

[Claim 1]

A method for checking nutrient attenuation in a frozen food, the method comprising:
5 a step of performing an accelerated test on a frozen food; and
a step of analyzing a nutrient contained in the frozen food subjected to the accelerated
test, wherein

the accelerated test is performed at 0°C or higher and under a high pressure condition
of 90 MPa or more.

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[Claim 2]

The method for checking nutrient attenuation in a frozen food according to claim 1,
wherein the accelerated test is performed at 10°C to 60°C and under a high pressure condition
of 90 MPa to 600 MPa.

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[Claim 3]

The method for checking nutrient attenuation in a frozen food according to claim 1
or 2, wherein the nutrient is 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,
20 folic acid, pantothenic acid, biotin, vitamin C, an n-3 polyunsaturated fatty acid, or an n-6
polyunsaturated fatty acid.