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(54) Title: A METHOD FOR PRODUCING PACKAGED KIMCHI WITH PRESERVATIVE CAPACITY AND QUALITY TO BE ENHANCED

(57) Abstract: This invention is related to a method for producing packaged kimchi with preservative capacity and quality to be enhanced. In this invention, Chinese cabbage and seasoning are fermented separately. When fermenting the salted Chinese cabbage, Leuconostoc sp. bacteria of 103–108/g is added as a starter. The fermented Chinese cabbage is washed with water and treated with NaClO for sterilization. Kimchi seasoning is fermented separately from the Chinese cabbage, and dried to remove bacteria. The dried seasoning is mixed with the sterilized fermentation water obtained from the fermentation of the Chinese cabbage to make the liquefied dressing. Then, the liquefied dressing is mixed with the fermented Chinese cabbage, to which grapefruit seed extracts or mustard oil is added to make the kimchi. Then, a container is filled with the kimchi and sterilized fermentation water.

The container is sterilized at a low temperature to make a packaged kimchi with improved storage capacity and intact quality and appearance of ingredients. This way, the growth of lactic acid bacteria is restrained to prevent excessive acidification of the kimchi and gas development. As a result, this packaged kimchi maintains the same texture as that of natural kimchi, as well as the same taste as that of other ordinary packaged kimchi, while gas development is controlled during the circulation period and the fermentation is maintained at a steady state with a low concentration of lactic acid bacteria. This way, the fermentation does not proceed inside the can so that the can does not expand to explode at a room temperature of 35 °C or even in adverse conditions at 53 °C, while maintaining the original taste.
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[DESCRIPTION]

[Invention Title]
A METHOD FOR PRODUCING PACKAGED KIMCHI WITH
PRESERVATIVE CAPACITY AND QUALITY TO BE ENHANCED

[Technical Field]
This invention relates to a method for producing packaged kimchi with
preservative capacity and quality to be enhanced.

[Background Art]
Kimchi is Korea's unique fermented vegetable food, in which major materials
such as Chinese cabbage or Chinese radish are fermented together with various
additional materials. Kimchi is one of the essentials in Koreans' dietary life. With the
recent increase in the number of housewives who are more actively engaged in social
activities, as well as the development of the food service industry, the demand for
packaged kimchi is gradually on the rise. In addition, as kimchi gains wider
international recognition and popularity to become one of the international foods,
kimchi exports are increasing not only for overseas Koreans but also for foreigners,
which further increases the need for packaged kimchi. The conventional packaged
kimchi available in the market satisfies the need for convenience and the preference for
instant foods by shortening the time to prepare the food. However, it is still required to
meet the need for higher-quality kimchi and greater convenience. In particular, with the
increase in Korea's national income and the following hike in people's leisure activities
and opportunities to dine out, public demand for higher-class kimchi products, on top of convenience, is naturally on the rise.

However, kimchi continues to be fermented by various kinds of microbes and
enzymes during the storage process, and after a certain period of time, its texture is
softened and it generates a bad smell. As kimchi becomes inedible because of the deterioration in quality, it eventually loses its storage capacity. This is one of the many areas where packaged kimchi needs improvement. The period of circulation for kimchi in domestic is relatively short, usually less than seven days at normal temperature or two to four weeks for cold storage. After this period, the package swells up with gas, which causes damage and separation of the kimchi from the package container, thereby deteriorating the quality of the product.

Thus, it is important to come up with a method that would extend the preservative capacity of kimchi in order to enhance its commercial value as a product. In an effort to improve the preservative capacity of kimchi, various research on the use of radiation and the addition of food preservatives have been carried out. However, they have failed to come up with any alternative since customers tend to shun away from kimchi that undergo such chemical treatments. Research on this matter are currently being carried out in various areas, including a buffer to control changes in the pH, additions of Na-acetate and Na-malate that have an acid-buffer function, and additions of salt mixtures such as a mixed salt of phosphate and Na-citrate. Many studies have already been carried out on how to slow down the speed of fermentation and extend the circulation period of kimchi by adding preservatives such as sorbic acid, polybutyl benzoate and sodium dehydroacetate, or by adding a pH buffer with a mixture of citric acid and sodium citrate. It was reported that kimchi in which the fermentative sugar was removed showed the positive effect of being preserved for a longer period of time. Other studies on kimchi manufacturing have been actively promoted, including retort pouch storage, heat-applied sterilization, addition of preservatives, addition of supplementary materials, and canning process. In particular, research on the inhibition of the fermentation process through the addition of natural preservatives is actively underway.

As for patents on methods to improve the preservation capacity of kimchi, Korean Patent No. 1965-485 in the name of Lee Shi-Ja introduced a manufacturing
method for canned kimchi wherein the number of lactic acid bacteria and the acidity of kimchi are controlled, and kimchi is contained in a can and sterilized with heat. Korean Patent Publication No. 1989-6152 in the name of Daesang Corporation is related to a manufacturing method of kimchi cans whose preservation capacity is improved by adding fatty acid monoglyceride and other materials to enhance preservation. Korean Patent Publication No. 1992-14413 in the name of Sunhwa Foods Corporation is directed to a manufacturing method of low-acidic kimchi cans where kimchi still possess a good texture by soaking low-acidic canned food materials in the kimchi liquid, then heating and acidifying them. Korean Patent Publication No. 2002-42558 owned by Lee Jung-Pyo relates to a manufacturing method of saury cans with kimchi. In this method, ripe kimchi and saury are mixed with seasoning and sterilized under high pressure.

Although there have been many research on kimchi cans that aim to satisfy both storage capacity and the sensory aspects, the reality is that it is still difficult to commercialize canned kimchi that can last for a long period of time at room temperature and satisfy the various tastes of customers. Canned kimchi that are currently sold in the Korean market are mostly for kimchi stew due to the difficulty of long-term storage at room temperature or just a mixture of ripe kimchi and fish. Consequently, these canned kimchi products have failed to receive good market responses, resulting in low sales performances.

In order to solve these problems concerning the short storage time, the most reliable way is to sterilize kimchi with heat to kill lactic acid bacteria. However, taking into consideration the quality of kimchi, the characteristics of the microbes and economic feasibility, it will be more suitable to improve storage capacity without the heat-applied sterilization of Chinese cabbage. Since gas is generated in the early stage of kimchi fermentation, it is important to have the kimchi fermented before it is processed into a can, so that the gas is removed prior to the packaging process. Thus, it is necessary to come up with methods to maintain the unique tastes, freshness, color
and appropriate turbidity of kimchi by maturing it without heat, while restraining gas expansions in the course of distribution, acidification by excessive organic acids, material softening due to the enzymes from kimchi itself and other microbes, and the breeding of microbes that generates discoloration of the pigments. When kimchi is matured excessively, the pH is lowered too much by acid-resistant microbes, which causes unpleasant taste and smell and softens the Chinese cabbage. Thus, it is important to restrain the growth of these microbes in order to prevent the over-maturity of kimchi.

[Disclosure]

[Technical Problem]

Taking into consideration the conventional technological problems and necessities described above, the inventors tried to come up with a packaged kimchi whose storage capacity and appearance are both improved at the same time. For this, various techniques were adopted in the various stages of kimchi-making, including in the salting and fermentation stages of the kimchi and in the fermentation and drying stages of the kimchi seasoning. In detail, the main materials of the kimchi and the seasoning were separately fermented in order to prevent gas formation due to fermentation after the packaging process, and other solutions were added to prevent microbes from multiplying.

Thus, the purpose of this invention is to provide a method to make a packaged kimchi with improved storage capacity and quality.

[Technical Solution]

The abovementioned purpose of this invention was achieved as following: After salting the materials of kimchi such as Chinese cabbage, the Chinese cabbage was fermented to pH 4.5~5.0. In order to use fermented water after fermentation as filling water, it was additionally fermented to pH 3.8~4.5. The fermented Chinese cabbage was cut into appropriate sizes and washed in water to remove bacteria. Then,
200~2000 ppm of NaClO(sodium hypochlorite) was added and the material was sterilized one to three times for 5 to 15 minutes. Kimchi seasoning was fermented and dried separately from the Chinese cabbage to make a dried seasoning containing salted water and salted shrimps. The dried seasoning was mixed with the sterilized and fermented water obtained from the fermentation of the Chinese cabbage to make a liquefied dressing. The liquefied dressing was then mixed with the fermented Chinese cabbage, and 1000~2000 ppm of grapefruit seed extracts (GFSE) or 200~800 ppm of mustard oil was added to make kimchi. Then, the kimchi was mixed with the sterilized and fermented water and the container was filled up to 80~100%. The filled container was sterilized for 10~40 minutes at 55~65°C to make a packaged kimchi with preservative capacity and quality to be enhanced.

a method for producing packaged kimchi with preservative capacity and quality to be enhanced, which are suggested in this invention, is characterized by comprising the following steps:

a salting step of preserving a kimchi material with 10% salt water for 10~12 hours at 5°C to produce a salted kimchi material and fermented water, wherein the kimchi material is any one selected from the group consisting of Chinese cabbage, leaf mustard, young radish, radish, leeks, sesame leaf, Korean lettuce and Korean leek and salt water is adjusted to pH 4.0~4.3 with acetic acid;

a fermentation step of adding water and glutinous rice paste or wheat flour paste to the salted kimchi material, and fermenting the kimchi material to pH 4.5~5.0 and the fermented water to pH 3.8~4.5 at 20°C at the final salinity of 2.5%, wherein the added water is one to three times of the weight of the salted kimchi material, the added glutinous rice paste or wheat flour paste is 2.5% of the weight of the kimchi material and water, the glutinous rice paste is prepared by mixing glutinous rice and water at a ratio of 2:8;

a sterilization step of washing the fermented kimchi material with water and sterilizing with NaOCl;
a seasoning making step of fermenting kimchi seasoning containing either 22% salt water or salted shrimp at 20°C to pH 4.3~4.0, and air-drying the kimchi seasoning at 58°C for 8~12 hours or vacuum-drying for 8 hours at 80°C to produce dry seasoning;

a kimchi making step of mixing a liquefied dressing and the kimchi material and adding 1000~2000 ppm of GFSE or 200~800 ppm of mustard oil to produce kimchi, wherein the liquefied dressing is prepared by mixing the dry seasoning and the sterilized and fermented water(pH 3.8~4.5) obtained from the said fermentation step at a ratio of 10:7, the kimchi material is any one selected from the group consisting of Chinese cabbage, leaf mustard, young radish, radish, leeks, sesame leaf, Korean lettuce and Korean leek;

a packaging step of filling a container up to 80~100% with 80% of the prepared kimchi and 0~20% of the sterilized and fermented water(pH 3.8~4.5); and,

a low temperature sterilization step of sterilizing the filled container at 55~65°C for 10~40 minutes.

In order to improve the storage capacity of the packaged kimchi, the following hurdle techniques were adopted in this invention:

First, the Chinese cabbage and the seasoning are separately fermented. In order to get rid of the Lactobacillus bacteria, which has a strong resistance to heat treatment, when the Chinese cabbage is fermented, Leuconostoc sp. bacteria (or fermentation fungi: lactic acid bacteria that makes the unique taste and generates bacteriocin) of $10^3$~$10^8$/g is added with a starter.

Second, the fermented Chinese cabbage is cut into appropriate sizes and washed with water(pH 4.0).

Third, 200~2000 ppm of NaClO is added to the fermented Chinese cabbage. The mixed ingredient is sterilized at pH 4.0 for 5~15 minutes to kill the lactic acid bacteria before they are placed inside the container.

Fourth, when making kimchi by mixing Chinese cabbage and dried seasoning, 1000~2000 ppm of GFSE or 200~800 ppm of mustard oil is added. Since they are
natural antibiotic substances, they have a synergistic effect in curbing the growth of bacteria. As for GPSE, the maximum sterilizing effect is achieved with a concentration of 1000~2000 ppm without metallic or other bad smells. The most desirable concentration is 1500 ppm. When mustard oil is over 800 ppm, the spicy taste became too strong and therefore the unique taste of kimchi deteriorates. When it is under 200 ppm, the sterilizing effect significantly deteriorates. Thus, 500 ppm is deemed to be the most desirable.

Fifth, the kimchi seasoning is fermented at 20°C to pH 4.0~4.3, and then dried either with hot air at 58°C for 8~12 hours or in a vacuum for eight hours at 80°C.

Sixth, the container is filled with kimchi and sterilized for 10~40 minutes at 55~65°C for final sterilization.

The packaged kimchi manufactured through these stages can control the growth of Lactobacillus sp. Bacteria, as well as the creation of other bacteria, so that the number of bacteria is maintained at a steady state. This way, gas is not generated during the storage period, and therefore, the storage period can be extended. Thus, the packaged kimchi manufactured through the methods suggested in this invention does not contain germs such as colon bacilli, and the final amount of lactic acid bacteria is adjusted down to $10^1$ $10^3$/g.

Meanwhile, kimchi seasoning is fermented separately from the Chinese cabbage to make the dried seasoning. The ingredients of kimchi seasoning include dried red pepper powder, garlic, ginger root, sugar and radish. Instead of the commonly used salted anchovies, salt water or salted shrimps with the same amount of salinity are added, fermented and dried. This greatly enhances the appearance of the dried seasoning. In addition, in order to enhance the texture of the seasoning, it should be fermented at 20°C to pH 4.0~4.3.

When filling the container with kimchi, the kimchi soup should be restored with the dried seasoning so that the unique taste of kimchi is recovered. For this, the sterilized fermentation water (pH 3.8~4.5) obtained from fermenting the Chinese
cabbage is added. When the sterilized fermentation water is under pH 3.8, the packaged kimchi develops a metallic smell. Thus, pH of the sterilized fermentation water should be between 3.8 and 4.5. pH 4.0 is deemed to be the most desirable.

The dried seasoning is mixed with the sterilized fermentation water obtained from the fermentation of the Chinese cabbage to make the liquefied dressing. The liquefied dressing is mixed with the fermented Chinese cabbage, in which 1000~2000 ppm of GFSE or 200~800 ppm of mustard oil is added, to make the kimchi. Then, the kimchi is mixed with the sterilized fermentation water and the container is filled up to 80~100%. This way, a packaged kimchi with superior storage capacity and favorable sensory features is achieved.

The packaging containers used in this invention are not limited to any specific type. Ordinary containers, including steel cans, glass bottles, plastic or aluminum containers, will be fine. However, a steel can is deemed to be the most desirable.

As for the kinds of kimchi, this method will be available for making any sort of kimchi that belongs to the category of kimchi, including Chinese cabbage kimchi, leaf mustard kimchi, cubed white radish kimchi, white kimchi, young radish kimchi, Korean lettuce kimchi, Korean leek kimchi, sesame leaf kimchi and leek kimchi. In the demonstrations described below, Chinese cabbage kimchi was used as the example for a more detailed explanation.

[Advantageous Effects]

As described above, this invention is related to a method for producing packaged kimchi with preservative capacity and quality to be enhanced. In this invention, Chinese cabbage and seasoning are fermented separately. When fermenting the salted Chinese cabbage, Leuconostoc sp. bacteria of $10^3$~$10^8$/g is added as a starter. The fermented Chinese cabbage is washed with water and treated with NaClO for sterilization. Kimchi seasoning is fermented separately from the Chinese cabbage, and dried to remove bacteria. The dried seasoning is mixed with the sterilized fermentation
water obtained from the fermentation of the Chinese cabbage to make the liquefied
dressing. Then, the liquefied dressing is mixed with the fermented Chinese cabbage, to
which grapefruit seed extracts or mustard oil is added to make the kimchi. Then, a
container is filled with the kimchi and sterilized fermentation water. The container is
sterilized at a low temperature to make a packaged kimchi with improved storage
capacity and intact quality and appearance of ingredients. This way, the growth of
lactic acid bacteria is restrained to prevent excessive acidification of the kimchi and gas
development. As a result, this packaged kimchi maintains the same texture as that of
natural kimchi, as well as the same taste as that of other ordinary packaged kimchi,
while gas development is controlled during the circulation period and the fermentation
is maintained at a steady state with a low concentration of lactic acid bacteria. This way,
the fermentation does not proceed inside the can so that the can does not expand to
explode at a room temperature of 35°C or even in adverse conditions at 53°C, while
maintaining the original taste.

[Description of Drawings]

Fig. 1 shows the overall manufacturing processes of the packaged kimchi of
this invention.

Fig. 2 shows pH of the canned kimchi of this invention.

Fig. 3 shows the number of lactic acid bacteria in the canned kimchi of this
invention.

Fig. 4 shows the number of lactic acid bacteria with different concentrations of
NaClO added to the fermented Chinese cabbage.

Fig. 5 shows pH and acidity by concentration of NaClO in kimchi.

Fig. 6 shows the number of lactic acid bacteria by concentration of NaClO in
kimchi.

Fig. 7 shows the results of the sensory tests by concentration of NaClO in the
canned kimchi of this invention.
Fig. 8 shows pH and acidity of kimchi by sterilization temperature of the kimchi can of this invention.

Fig. 9 shows the number of lactic acid bacteria in the canned kimchi by sterilization temperature.

Fig. 10 shows the results of the sensory tests by the packing rate of the packaging container.

[Best Mode]

Example 1: a method for producing packaged kimchi

(1) Preparation of dried seasoning

The seasoning for the kimchi was manufactured using the standardized method for Chinese cabbage kimchi, which was suggested by the Kimchi Research Institute of Pusan National University. As for the ratio of the ingredient mixtures, 3.5% of dried red pepper powder, 1.4% of garlic, 0.6% of ginger root, 1.0% of sugar, 13.0% of radish and 2.2% of salt water were added when the Chinese cabbage is 100. 50mL of water was added per kg of mixed seasoning and fermented for seven days at 20°C to pH 4.3. The fermented mixed seasoning was dried either for 8 hours at 58°C by using a hot air drier (J-300M manufactured by JISICO Co., Ltd.) or for 8 hours at 80°C by using a vacuum drier (manufactured by Dongwon F&B). Then, it was stored at -5°C.

(2) Fermentation and sterilization of Chinese cabbage

In order to enhance the texture of Chinese cabbage, the Chinese cabbage was cut into four segments, in which 10% salt water adjusted to pH 4.0 with citric acid or acetic acid was added. The Chinese cabbage was salted for 10 hours at 5°C, and washed with water and drained for three hours. Then, the Chinese cabbage was added with water, weighing twice that of the Chinese cabbage. Glutinous rice starch or wheat flower paste was prepared, in which glutinous rice and water were mixed at a ratio of 2:8. This was mixed with water to make 2.5% of the weight of the kimchi material and water, and then added to the prepared kimchi material. The final salinity was adjusted
to 2.5% with sun-dried salt (Woo Il Salt Corp.) [Chinese cabbage: salt water (2.5% concentration): glutinous rice starch = 1kg: 2L: 50g], and then these ingredients were fermented at 20°C to pH 5.0. At this stage, the fermentation water was fermented to pH 3.8~4.5. However, it was continuously fermented until it reached pH 4.0 in order to use it as packing water in the canning process. In addition, wheat flour paste can replace the glutinous rice starch in the same ingredient percentage.

In addition, in order to examine the influence of starters on the fermentation speed of Chinese cabbage, *Leuconostoc* sp. Bacteria of $10^3$ $10^9$/g, which generates bacteriocin such as *Leuconostoc mesenteroides* and *Leuconostoc citreum*, were added as a starter. The starter was obtained from kimchi from the Kimchi Research Institute of Pusan National University.

The fermented Chinese cabbage was sterilized either through ozone treatment or NaClO treatment. The detailed treatment methods are as follows:

As for the ozone treatment, the fermented Chinese cabbage was washed in flowing water three times, cut into 3 cm x 3 cm, and soaked for five minutes in water sufficient enough to sink the Chinese cabbage. The ozone concentration of this water was adjusted to 1.5 ppm by using an ozone emitter (manufactured by Jeil Starpack).

As for the NaClO treatment, water weighing twice that of the fermented Chinese cabbage was added to the Chinese cabbage. Then, the Chinese cabbage was washed with water once and cut into 3 cm x 4 cm. The pieces of the Chinese cabbage were washed once again with water (pH 4.0). NaClO (manufactured by YAKURI PURE CHEMICAL CO., LTD. / TYOTO JAPAN) was fused in the water weighing twice that of the Chinese cabbage until it reached a concentration of 1500 ppm with pH 4.0. Then, the Chinese cabbage was soaked in this NaOCl-added water for 15 minutes with two sessions of sterilization, and was dried for two to three hours.

(3) Production of packaged kimchi
The liquefied dressing of 50g was mixed per kg of fermented and sterilized Chinese cabbage, in which 1500 ppm GFSE [model DF-100, manufactured by FA Bank Co., Ltd.] (1.5g of GFSE 1.5g/10g of distilled water) was added, and then the whole ingredients were packed in the container. At this stage, the liquefied dressing was made by mixing the dry seasoning and the sterilized fermentation water (pH 4.0) obtained from the fermentation of the Chinese cabbage. The two were mixed at a ratio of 10:7. Instead of GFSE, 500 ppm mustard oil (MDO) may be added.

In order to examine the improvement of storage capacity and the quality of packaged kimchi depending on the packing rate, tests were conducted with different packing rates of 80% and 100%. When the packing rate was 80%, only solid materials made up of Chinese cabbage and the liquefied seasoning were used, whereas in the test with a 100% packing rate, 80% of the ingredients were solid materials and the rest of the 20% was sterilized fermentation water (pH 4.0) (98g of kimchi: 28g of fermentation water).

Steel cans were used as packaging containers. These were 2-piece cans with a content volume of 100g (H : 30 mm x D : 75 mm, a dubbed portable can as another name) or 3-piece cans with a content volume of 170 g (H : 50 mm x D : 75 mm, often dubbed portable cans). The inside of these cans was coated twice with epoxyphenol. The cans were supplied by Hanil Can Making Corporation, and a semitro vacuum can seamer manufactured by Samjin Precision Co., Ltd. was used in the steel can manufacture.

In order to improve the storage capacity of the packaged kimchi, it was sterilized for 30 minutes at 65°C. After the low temperature sterilization, the packaged kimchi was rapidly cooled for 30 minutes at 5°C.

[Mode for Invention]

Example 2 : Test of the storage capacity of canned kimchi and Development of optimal conditions
In order to find out the storage capacity and quality of the canned kimchi manufactured according to Example 1, chemical tests (i.e., pH and acidity) and sensory tests were conducted depending on the conditions of the kimchi manufacturing processes. The test methods used in this invention were as follows:

(1) Measurement of pH and acidity

pH was measured with a pH meter (Istek model 735-P, Korea) at room temperature. Acidity was measured by using the AOAC method. For this, distilled water was added to 20 ml of the test material to dilute it by 20 times. 10 ml of the diluted matter was taken for the acidity test. 1 ml of 0.1% phenolphthalein was added as an indicator and the matter was titrated with 0.1N NaOH until it reached the end point where it turned pink. The titration value was converted into the percentage of lactic acid.

\[
\text{Lactic acid (\%) = } \frac{(\text{ml of 0.1N NaOH x normality of NaOH x 0.09})}{\text{Sample weight (g)}} \times 100
\]

(2) Measurement of the number of lactic acid bacteria

Plate count agar technique was used in measuring the number of lactic acid bacteria. 1 ml of the test liquid was diluted with sterilized distilled water by stage. 0.1 ml of each of the diluted liquid was mixed with the 10 ml MRS medium, which had been prepared by being melted with heat and cooled at 43-45°C. A plate was made on the petri dish with the prepared mixture. Then, the number of colonies cultivated in the incubator at 37°C was counted and converted into the number of lactic acid bacteria. As for the medium for Lactobacillus, modified LBS agar medium (m-LBS medium, see Table 1) was prepared by adding acetic acid and sodium acetate to Lactobacillus selection medium (LBS medium) in order to curb the growth of Pediococcus. The m-LBS medium was painted over the plate for cultivation for two days at 37°C and then the number of Lactobacillus was counted. As for the Leuconostoc selection medium,
phenylethyl alcohol sucrose agar medium (PES medium, see Table 1) was prepared by adding phenylethyl alcohol and sucrose to the MRS broth medium, and then *Leuconostoc* was cultivated on the plate for three days at 15°C.

**[Table 1]**

| Compositions of m-LBS medium and PES medium |
|-------------------------------------------|----------------------------------|
| m-LBS medium                              | PES medium                       |
| Ingredients                                | Quantity (g/L)                   | Ingredients                         | Quantity (g/L)       |
| Peptone                                    | 10                               | Trypticase                          | 5.0                  |
| Beef extract                               | 10                               | Yeast extract                       | 0.5                  |
| Yeast extract                              | 5                                | Sucrose                             | 20.0                 |
| Glucose                                    | 2                                | (NH₄)₂SO₄                           | 2.0                  |
| Twin 80                                    | 1                                | MgSO₄·7H₂O                           | 0.244                |
| K₂HPO₄                                     | 2                                | KH₂PO₄                              | 1.0                  |
| Sodium acetate                             | 5                                | Phenyl ethyl alcohol                | 2.5                  |
| Ammonium citrate                           | 2                                | Agar                                | 15.0                 |
| MgSO₄·7H₂O                                 | 0.2                              |                                     |                      |
| Acetate                                    | 2.5 ml                           |                                     |                      |
| Sodium acetate                             | 35                               |                                     |                      |
| Agar                                       | 15                               |                                     |                      |

(3) Sensory tests

Eight experts who are well trained for sensory tests evaluated three test materials at one time based on the replicated randomized complete block design, and the test was repeated four times. The subjective test items included comprehensive appearance, smell, flavor and texture. The evaluation results were rated from 1 to 9, with 9 being the highest and 1 being the lowest.

The objective test items included sour smell, moldy smell, heating flavor, sour flavor, moldy flavor, metal taste and hardness of the texture. When it is close to 1, it means that it is impossible to sense the particular sense, and when it is close to 9, it means that they felt the particular sense very strongly. As for the sense of smell, it was evaluated by using the nose. As for the sense of taste, it was evaluated by feeling with the mouth and nose after chewing with the molar teeth many times. Hardness was
evaluated by sensing the degree of power required in chew the material twice or three times in the same direction as the fibroid material by using the front teeth. Sour smell and flavor were evaluated as a sense caused by acid, whereas the smell of greens and unripe flavor were evaluated by how much they remind the evaluator of the bitter taste of green leaves. Moldy smell and flavor were defined as unpleasantness from old kimchi.

(4) Measurement of texture

The texture was measured by using a Rheometer (Sun Scientific Co. CR-100D) (Conditions: Mode 1, Max 10kg, R/H Real 3kg, R/T Press 600mm/m, REP 1 3sec). The Chinese cabbage was cut from the root up to 10 cm by 3 cm x 4 cm to make the kimchi. Of the pieces, those with a thickness of 0.5–0.6 cm were selected for the evaluation. Each of the test materials was measured five times. Three similar values obtained from the five sets of tests were averaged.

Experiment 1: Test on the storage capacity of the canned kimchi

A kimchi can manufactured according to Example 1 was stored for 6 months at 20°C, and pH, acidity and number of lactic acid bacteria of the kimchi in the can were measured.

As seen in Fig. 2, the initial pH of kimchi was maintained at 4.0, which is an appropriate degree of maturity. Up to 90 days, pH was maintained constantly at this favorable condition. However, after 90 days, it was up a little bit. On the 180th day, it rose to 4.5. Acidity showed a similar tendency as pH, showing almost no change from the initial acidity of 0.4%, which proved high efficiency in storage.

In addition, as seen in Fig. 3, Leuconostoc mesenteroides was involved in fermentation in the early stage of kimchi fermentation. Afterwards, Lactobacillus plantarum and Lactobacillus brevis led the fermentation processes. Leuconostoc mesenteroides bred in large numbers in the early stage. Lactic acid bacteria generate
lactic acid and CO₂ simultaneously with breeding, which acidifies the kimchi and makes the condition anaerobic to restrain the growth of aerobic bacteria and prevent the kimchi from being sour to keep its unique taste. Manufacturing the kimchi can with ozone treatment, addition of GFSE and low temperature sterilization (at 65°C for 30 minutes) at the end was proven to be effective in curbing the growth of lactic acid bacteria. The results of the test on the storage of the can for 6 months showed that the lactic acid bacteria could not grow in kimchi.

**Experiment 2: Test on storage capacity depending on the manufacturing process of the canned kimchi**

Storage capacities were examined targeting canned kimchi that were manufactured in various conditions, such as conditions of sterilization of fermented kimchi, low temperature sterilization of kimchi, packing rates of the container, and addition of a fermentation starter.

**Experimental Example 1: Storage capacity of NaOCl-treated canned kimchi**

The fermented kimchi in Example 1 was sterilized with NaClO in various conditions, and the number of lactic acid bacteria was calculated. NaClO is widely used for its excellent sterilizing ability without causing any remaining toxicity.

As seen in the Figure 4, the extinction of lactic acid bacteria was observed when the fermented Chinese cabbage was sterilized for 5 minutes at 1.5 ppm ozone water. The result showed that *Lactobacillus* sp. bacteria were $10^7$ CFU/mL at the salinity of the salted Chinese cabbage, whereas the number was lowered to $10^6$ when the salinity was adjusted to 2.2%. When it was adjusted again to 2.5%, the number of bacteria further decreased. The number of *Leuconostoc* sp. bacteria showed a decreasing trend when the salinity was 2.2% and 2.5% compared to the original salinity of the Chinese cabbage. The higher the salinity, the smaller the number of bacteria. However, compared to the number of *Lactobacillus* sp. bacteria, the extinction rate was still low.
The decrease in the number of lactic acid bacteria was observed in the sterilization of the fermented Chinese cabbage with 1000 ppm NaClO for 5, 15 and 30 minutes. The longer the Chinese cabbage was soaked, the more powerful the effect of killing the lactic acid bacteria and *Lactobacillus* sp. bacteria were killed than *Leuconostoc* sp. bacteria. However, no significant decreasing effect was detected with the soaking periods of 10 minutes and 30 minutes. This is attributed to the fact that the concentration of NaClO could not be maintained at a constant degree during the soaking time since the concentration of NaClO rapidly falls from the moment the Chinese cabbage was soaked in the NaOCl-treated water. Thus, it is understood that soaking kimchi in NaClO for 15 minutes is the most appropriate. When the concentrations of NaClO were adjusted differently to 500 ppm, 1000 ppm, 1500 ppm and 2000 ppm and treated for five minutes, *Leuconostoc* sp. bacteria were lowered to $10^1$ with 1500 ppm NaClO treatment, compared to the control group of $10^8$, while *Lactobacillus* sp. bacteria were decreased to $10^2$ with the same NaClO concentration. This indicates that the effect of extinction was greater on *Lactobacillus* sp. bacteria compared to *Leuconostoc* sp. bacteria. Similar results were obtained from the treatment of 200 ppm NaClO for 10–30 minutes (No relative figures attached).

As for the sterilization effects from the use of ozone and NaOCl, both *Lactobacillus* sp. bacteria and *Leuconostoc* sp. bacteria were killed more by $10^1$ when treated with 1500 ppm of NaOCl. Although it was verified that the longer the period of time kimchi was soaked, the more lactic acid bacteria were killed, the number of bacteria did not decrease in proportion to time. In addition, more *Lactobacillus* sp. bacteria were killed than *Leuconostoc* sp. bacteria.

As a result of the NaClO treatments at different temperatures of 5°C and 20°C, the number of *Lactobacillus* sp. bacteria decreased to $10^6$ compared to the control group of $10^7$. However, the varied temperatures did not indicate any difference in the number of bacteria. The results were the same with *Leuconostoc* sp. bacteria. While the
number of bacteria in the NaOCl-treated group decreased, the temperature did not cause any difference.

Based on the results explained above, two Chinese cabbages were treated with 1000 ppm and 1500 ppm of NaClO separately. With these Chinese cabbages, kimchi cans were manufactured following Demonstration 1 and kept at 20°C for 28 days.

As seen in Fig. 5, the initial pH was similar, recording 4.0 for the 1000 ppm treated can and 4.2 for the 1500 ppm can. pH remained the same without much difference after 28 days of storage. As for acidity, the initial acidities were 0.39% for the 1000 ppm treated group and 0.5% for the 1500 ppm treated group, indicating that the latter was lower in acidity. This tendency continued until the 14th day when the acidity increased to some degree. It rose again on the 28th day.

As seen in Fig. 6, there were no Lactobacillus sp. bacteria initially in the 1000 ppm treated group. However, the number increased to $10^5$ on the seventh day and up to $10^7$ on the 14th day. Then, the number was maintained until the 28th day, when it fell to below $10^6$. In the 1500 ppm treated group, the bacteria did not appear until the 21st day. Meanwhile, Leuconostoc sp. bacteria were not detected at all for the entire period of storage (28 days) both in the 1000 ppm and 1500 ppm treated groups. When Chinese cabbage was sterilized with NaOCl, the sterilizing effect was greater for Lactobacillus sp. than for Leuconostoc sp. bacteria. Thus, it is understood that the concentration of NaClO influences the storage capacity of canned kimchi.

In order to find out the influence of NaClO concentrations in sterilizing Chinese cabbage on kimchi flavors, sensory tests were conducted for two kimchi cans treated with NaClO of 1000 ppm and 1500 ppm, respectively. As seen in Fig. 7, bitter, salty and sour flavors did not show much difference for the two kinds of canned kimchi with different concentrations of NaOCl. However, 1500 ppm NaOCl-treated canned kimchi showed better appearance of the content than 1000 ppm NaOCl-treated kimchi. The former also showed more favorable results in terms of moldy flavor and texture hardness.
Since 1500 ppm NaOCl-treated kimchi showed superior flavor, appearance and storage capacity in this experiment, it is understood that NaClO treatment with a concentration of 1000–2000 ppm can efficiently control bacteria and add excellence to the taste of kimchi.

Experimental Example 2: Storage capacity of canned kimchi depending on sterilization temperature

Since lactic acid bacteria on the surface of fermented kimchi was removed with NaClO and GFSE could not obtain a satisfactory level of storage capacity, low temperature sterilization was also conducted at 58°C and 55°C for 20, 30 and 40 minutes. In this test, kimchi sterilized at 65°C for 30 minutes, as described in Example 1, was used as a control group. As a representative experimental result, the result at 58°C was described.

As seen in Fig. 8, the initial pH at 58°C was 4.0, which did not show any difference between the two groups. However, after 40 minutes of sterilization at 58°C, pH of the experimental group slightly decreased compared to that of the control group. On the 28th day of storage, the experimental group showed pH 3.8, higher than the other groups. Acidity slowly rose with 40 minutes of sterilization at 58°C, whereas it rapidly increased with 20 minutes and 30 minutes of sterilization.

As seen in Fig. 9, the extinction effect on Lactobacillus sp. bacteria appeared weak in the groups sterilized for 20 and 30 minutes at 58°C. In the group treated for 40 minutes at 58°C, the bacteria were not detected initially. However, they rapidly grew during the storage period up to $10^8$ by the 14th day of storage. Afterwards, they showed similar growth speed as the other groups. The number of Leuconostoc sp. bacteria was initially $10^5$ in the group treated for 20 minutes at 58°C. However, the bacteria were all killed during the storage period and were no longer detected for the entire storage period of 28 days. In the groups treated for 30 and 40 minutes at 58°C, no bacterium was detected just like in the control group.
Experimental Example 3: Storage capacity of kimchi depending on the packing rate of the container

Fermented Chinese cabbage was sterilized with 1500 ppm NaClO for 15 minutes and was contained in 3-piece cans with different packing rates of 80% and 100%. The cans were then sterilized for 20, 30 and 40 minutes at 58°C. As for the 80% group, only kimchi filled the can, whereas in the 100% group, the can was filled 80% with kimchi and 20% with the sterilized fermentation water (pH 4.0) obtained from the Chinese cabbage fermentation stage. The packaged kimchi was stored for 28 days at 20°C, during which time its pH and acidity were observed. The detailed manufacturing processes of the packaged kimchi followed the descriptions in Example 1.

The test indicated a tendency where pH was higher and acidity was lower with a higher packing rate. However, they did not demonstrate any significant difference. As for lactic acid bacteria, the antibiotic effect on *Lactobacillus* sp. bacteria was higher by $10^4$ in each group with a 100% packing rate compared to the 80% packing rate group. In each group, the bacteria could not breed well with the 100% packing rate. This is understood to be due to an increase in the enhanced sterilization effect with the addition of fermentation water in the 100% packing rate.

*Leuconostoc* sp. bacteria could hardly survive in all groups in this test. This is consistent with the earlier results of the low temperature sterilization experiments, which indicated that the low temperature sterilization was more harmful to *Leuconostoc* sp. bacteria than to *Lactobacillus* sp. bacteria.

As seen in Fig. 10, as for the texture with different packing rates, hardness was higher by 20000 mm up to 14 days of storage for the 100% packing rate group with 20-minute sterilization at 58°C. The hardness became similar on the 21st day, and it became higher again on the 28th day of storage. The groups sterilized for 30 minutes at 58°C showed similar trends in hardness in the initial stage. However, the 100% packing rate group showed higher hardness thereafter, which lasted for the rest of the storage
period. With 40-minute sterilization at 58°C, similar results were obtained, with the 100% packing rate group showing higher hardness. Overall, the 100% packing rate group where water was added showed higher texture hardness.

As a result of the sensory tests with different packing rates, the sour flavor did not show much differences, whereas the 100% packaging rate group gained lower points in heating smell and moldy flavor, better results in overall appearances, and displayed excellence in comprehensive tests in terms of quality.

In conclusion, the 100% packing rate group showed better low-temperature sterilization effect as well as better quality of the contents than the 80% packing rate group. However, in the real manufacturing process, 20% of packing water may break the kimchi can depending on the mixture of the solid part and the liquid part. Thus, an 80~100% packing rate is deemed desirable.

Experimental Example 4: Storage capacity of kimchi depending on the addition of fermentation starters

Since the materials of kimchi cannot be sterilized with heat, the initial numbers and sorts of bacteria from kimchi materials vary, which makes it impossible to use the same fermentation system as in dairy products. This is why the cultivation of specific bacteria for kimchi cannot be adopted, unlike the case of fermented dairy products. One of the major problems in the development of kimchi starters is that, although a superior bacteria type is developed, a large number of them have to be added initially since the raw materials of kimchi cannot be sterilized, which causes difficulty in controlling the speed of fermentation of the kimchi and results in making the kimchi too sour.

In the early stage of fermentation, kimchi starts being fermented with the breeding of lactic acid bacteria such as *Leuconostoc mesenteroides*, and the growth of lactic acid bacteria reaches the maximum state when kimchi is in the best state for eating. It is known that when pH falls below 4.0 after the middle stage of fermentation,
*Lactobacillus plantarum*, a normal lactic acid bacteria with high resistance to acidity, breeds quickly to turn the kimchi sour.

Thus, in order to reduce the number of *Lactobacillus* sp. bacteria that survive after the low-temperature sterilization, and enhance the taste of kimchi, $10^3$ $10^8$ of *Leuconostoc* sp. Bacteria, including *Leuconostoc mesenteroides*, which produces bacteriocin in kimchi, were added when fermenting the Chinese cabbage. This way, the growth of *Lactobacillus* sp. bacteria and creation of other bacteria can be controlled during the fermentation of kimchi, resulting in improved storage capacity and ensuring equal quality for packaged kimchi.

**[Industrial Applicability]**

Accordingly, this invention will greatly contribute to the food industry by guaranteeing highly improved storage capacity as well as excellence in quality of the product.
[CLAIMS]

[Claim 1]

A method for producing packaged kimchi with preservative capacity and quality to be enhanced, which comprises the following steps:

5 a salting step of preserving a kimchi material with 10% salt water for 10~12 hours at 5°C to produce a salted kimchi material and fermented water, wherein the kimchi material is any one selected from the group consisting of Chinese cabbage, leaf mustard, young radish, radish, leeks, sesame leaf, Korean lettuce and Korean leek and salt water is adjusted to pH 4.0~4.3 with acetic acid;

10 a fermentation step of adding water and glutinous rice paste or wheat flour paste to the salted kimchi material, and fermenting the kimchi material to pH 4.5~5.0 and the fermented water to pH 3.8~4.5 at 20°C at the final salinity of 2.5%, wherein the added water is one to three times of the weight of the salted kimchi material, the added glutinous rice paste or wheat flour paste is 2.5% of the weight of the kimchi material and water, the glutinous rice paste is prepared by mixing glutinous rice and water at a ratio of 2:8;

15 a sterilization step of washing the fermented kimchi material with water and sterilizing with NaOCl;

a seasoning making step of fermenting kimchi seasoning containing either 22% salt water or salted shrimp at 20°C to pH 4.3~4.0, and air-drying the kimchi seasoning at 58°C for 8~12 hours or vacuum-drying for 8 hours at 80°C to produce dry seasoning;

20 a kimchi making step of mixing a liquefied dressing and the kimchi material and adding 1000~2000 ppm of GFSE or 200~800 ppm of mustard oil to produce kimchi, wherein the liquefied dressing is prepared by mixing the dry seasoning and the sterilized and fermented water(pH 3.8~4.5) obtained from the said fermentation step at a ratio of 10:7, the kimchi material is any one selected from the group consisting of Chinese cabbage, leaf mustard, young radish, radish, leeks, sesame leaf, Korean lettuce and Korean leek;
a packaging step of filling a container up to 80~100% with 80% of the prepared kimchi and 0~20% of the sterilized and fermented water (pH 3.8~4.5); and,
a low temperature sterilization step of sterilizing the filled container at 55~65°C for 10~40 minutes.

【Claim 2】
The method for producing packaged kimchi as set forth in claim 1, wherein the fermented kimchi material is sterilized one to three times for 5 to 15 minutes with NaClO melted in one to three times of water of the fermented kimchi materials so as to make a concentration of 200~2000 ppm, pH 4.0.

【Claim 3】
The method for producing packaged kimchi as set forth in claim 1, wherein Leuconostoc sp. bacteria of 10³~10⁶/g are added as a starter when fermenting any one selected from the group consisting of Chinese cabbage, leaf mustard, young radish, radish, leeks, sesame leaf, Korean lettuce and Korean leek.

【Claim 4】
The method for producing packaged kimchi as set forth in claim 1, wherein the container is a steel can, a glass bottle, a plastic container or an aluminum container.
FIG. 1

Chinese cabbages, leaf mustard, radish, leek, sesame leaves and etc.

Salting [in 10% salt water adjusted to pH 4.0~4.3 with citric acid or acetic acid at 5°C for 10~12 hours]

Fermentation [2.5% salt water (1~3 times of weight of the cabbages) + 2.5% glutinous rice starch, 20°C, fermented water: pH 3.8~4.5; Chinese cabbages: pH 4.5~5.0]

Cutting (3 x 4 cm)

Sterilization with NaClO (100~2000ppm, for 5~15 minutes, 1~3 times)

Available to manufacture in a container such as a can, bottle, plastic or aluminum container, and to store over 6 months at room temperature

Washing with water

Controlling the growth of Lactobacillus sp. bacteria

Seasoning mixtures (red pepper powder, radish, garlic, ginger, sugar and salt)

Fermentation [for 7 days at 20°C, pH 4.0~4.3]

Vacuum dry (for 8 hours at 80°C) or Hot air dry (for 8~12 hours at 58°C)

Mixing and Packing [fermented cabbages + 5% liquefied dressing (dry seasoning + sterilized and fermented water (pH 3.8~4.5)) + addition of grapefruit seed extracts or mustard oil]

Vacuum seamsing

Low temperature sterilization (at 55~65°C for 10~40 minutes)

Rapid cooling (at 5°C for 30 minutes)

Product
FIG. 2

pH

Acidity (%)

Storage period (days)
FIG. 3
FIG. 5

○ : NaClO 1000 ppm 10; △ : NaClO 1500 ppm 10
FIG. 6

○ : NaClO 1000 ppm 10; △ : NaClO 1500 ppm 10'
FIG. 7

○: NaClO 1000 ppm, 10'
△: NaClO 1500 ppm, 10'

Appearance
overall quality
Sour smell
Hardness
Heating flavor
Moldy flavor
Moldy smell
Metal taste
Salty flavor
Bitter taste
Sour flavor
FIG. 8

- : Control (65°C, 30'),  ○: 58°C, 20',
  △: 58°C 30', □: 58°C, 40'

- : pH
- : Acidity (%)
FIG. 9

- Control (65°C, 30'), ○: 58°C, 20'
- △: 58°C 30', □: 58°C, 40'

**Lactobacillus sp. (log CFU/ml)**

**Leuconostoc sp. (log CFU/ml)**

Storage period (days)
FIG. 10

○: control group(65℃, 30', 80%), △: 58℃, 40', 80%
□: 58℃, 40' 100%
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC7 A23B 7/10**

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)

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

- Korean Patents and applications for inventions since 1975
- Korean Utility models and applications for Utility models since 1975
- Japanese Utility models and application for Utility models since 1975
- Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
  - eKIPASS, Delphion, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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Further documents are listed in the continuation of Box C.  

See patent family annex.

- * Special categories of cited documents:
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**Date of the actual completion of the international search**

13 OCTOBER 2005 (13.10.2005)

**Date of mailing of the international search report**

14 OCTOBER 2005 (14.10.2005)

**Name and mailing address of the ISA/KR**

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Facsimile No. 82-42-472-7140

**Authorized officer**

KIM, Jae Hyun  
Telephone No. 82-42-481-5632

Form PCT/ISA/210 (second sheet) (April 2005)
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