A NEW SPECIES OF PLANT BAEMOOCHAE AND METHOD FOR BREEDING THE SAME

Abstract: The present invention relates to a new plant BAEMOOCHAE and method for breeding the same and can provide the plant BAEMOOCHAE characterized in that survive in natural environment and have strong disease tolerance, economical efficiency in seed production and enough uniformity as a vegetable crop. It was bred by hybridizing Chinese cabbage cultivars “JUNSHUNG” as the mother and radish cultivars “BAEKKYOUNG” as the father.
A NEW SPECIES OF PLANT BAEMOOCHAE AND METHOD FOR BREEDING THE SAME

TECHNICAL FIELD

The present invention relates to a new plant "BAEMOOCHAE" and method for breeding the same. Particularly, it is a new plant characterized in that can survive alone under the natural environment, has strong tolerance to viral disease, is economically efficient in seed production and has enough purity as a vegetable crop. It was bred by hybridizing Chinese cabbage, Brassica campestris ssp. pekinensis cultivars (F1 hybrid) "JUNSEUNG" as the mother and radish Raphanus sativus cultivars "BAEKKYOUNG" as the father.

BACKGROUND ART

Chinese cabbage and radish are edible vegetables that are rich in vitamin and used as KIMCHI materials around Korea, Japan and China. Chinese cabbage is originated from China. Its outer leaf is like a hen's egg upside down and green or light green in the color and has big wide midrib in the base central part. The leaves from the short stem are spread to the ground and have irregular division like the toothed wheel and wrinkle on the edge. The short stem is almost covered with the leaves. The flower is a cruciform corolla (4-petaled and cross-shaped corolla) and a yellow raceme blooming from lower part to upper part. There are one pistil and six stamens, 4 of them are long and the others are short. The fertilization is possible 4 to 5 days before blooming because pistil becomes mature first. The fruit is like the long horn, 2-chambered and the thin membrane is located between the chambers. When the fruit ripens fully, pericarp gets split from front end and seeds drops. One fruit has 20~28 ovules and produces 18~25 seeds, if fertilized in normal condition.

Chinese cabbage, mainly used as KIMCHI materials, contains 33 IU vitamin A, 100 IU carotene, 0.05 mg vitamin B1, 0.05 mg vitamin B2 and 40 mg
vitamin C per 100 g of cabbage. Vitamin A is rich in green part of the leaf, little in the white part. Chinese cabbage likes cool climate and the range of adaptability to temperature is narrow. The optimum temperature for growth is 18 to 21 °C. The growth is bad under 10 °C and stops under 5 °C, and also it is bad in high temperature over 23 °C. Especially, the number of leaves increases no more and only the differentiated leaves grow out after flower bud differentiation. Because the differentiation of flower bud happens in low temperature less than 12 °C, it occurs from early October and the bolting occurs on next spring in the central districts. If the seed is sowed in early spring, the low temperature on early stage of the growth causes flower bud differentiation prior to having enough leaves and the bolting before head formation. The time of bolting in the spring crop differs according to varieties, but it starts generally as temperature is getting higher and the blooming occurs when day temperature reaches over 15 °C. When low temperature about -1 °C is treated to seeds germinated for a month, bolting and flowering happens around 30 days after sowing. So the flowering is possible any time.

There are various cultivars of Chinese cabbage. Around 40 years ago, open pollinated varieties including Sandong, loose-headed Sandong, Seoul, Jikye, Juksun, Jibu, Gaha, Poduryeon, Aeji, Gweonsim, etc. were grown. But now most of cultivars are F1 hybrids. The culturing method differs according to the season and the place. There are several cropping methods, such as spring cultivation that is to cultivate in the season which temperature is getting higher, summer cropping in the alpine area to avoid high temperature in the low land and autumn cultivation that is to grow in the most favorable condition.

Meanwhile, radish is one of the 3 major vegetables with Chinese cabbage and hot pepper in Korea. The upper part of the column-like root is the hypocotyl and the lower part is the real root. But the boundary between them is not clear. The leaves grown from the root are the pinnate compound and crossed each other and have hairs on he surface. The leaf is generally lyrate in division
and the top lamina is biggest. When the flower stalk is grown around to 0.1m long, branches grow out and the compound racemes develop on it. The flower with the short peduncle blooms in April to May and its color is light purple or white and the petals are arranged in cruciate. The flower has one pistil and six stamens of which 4 are longer than the other two. The fruit is 4 to 6 cm-long nuts and does not burst. There are 2 to 10 seeds per pod. The seeds are like hen's egg, reddish brown, yellow or gray brown.

Most varieties of radish cultivated in Korea are Korean native one originated from China and Japanese ones introduced from Japan via China. Typical Korean native varieties with big root were JINJUDAEPYOUNG, YONGHYUN, SONGJUNG, SEOUL, YESUNGBANCHUNG. Nowadays most of the leading cultivars are F1 hybrids cultured in the fall season. Big root radish is usually used as materials for various kinds of KIMCHI. The hypocotyl consisted of the root is 7 to 8 cm long and the real root is 15-25 cm long and the root weighs around 800g. The cultivation period is about 2.5 months. Besides, there is SEOUL BOMMOO for spring crop which root is consisted of the hypocotyl 2 to 3 cm long and the real root 8 to 9 cm long and weighs around 300g. Another spring radish, DAEHYOUNGBOMMOO, is widely cultivated recently. Japanese radish is cultivated mainly for pickled radish, and the typical variety is MINOWASE. As the Occidental radish, there are 20-day's radish that is able to be harvested in 20 days after sowing and 40-day's radish that is able to be harvested in 40 days after sowing. The root of the former is red and round and the latter is red and long like the general radish. There is also black radish which is generally gray brown and used for medicine in Occident. A wild radish, GAETMOO, Raphanus sativus var. hortensis for. raphanistroides is native in JEJU island and southern part of the east sea costal. Its root is thinner and harder and the leaf is smaller.

Autumn radish, which is the main cropping is sowed in mid or late August and harvested in November. Spring radish is sowed in March or April in
greenhouse and harvested in May or June. Summer radish is cultivable in the highland over 600m absolute altitudes such as DAEKWANRYONG in Korea.

The method for seeding is generally the drill planting or the hill seeding. The radish likes cool climate. Its floral axis usually doesn't grow out, but when it last below 10°C for over two weeks, the floral bud develops and the floral axis grows. So the control of temperature is important. Repeating of dry and wet during growing period causes cracking of the root. So it is needed to be careful in irrigation.

Radish supplies not only vitamin C in winter but also digestion enzyme diastase. Radish has been diversely used in making KIMCHI, dried radish, pickled radish, and its seeds are also used for medicinal purpose such as expectorants and stomachics.

Meanwhile, many trials to hybridize Chinese cabbage and radish had been made, but few hybrid seed was obtained. It was because of degeneration of the hybrid seeds in the earlier stage of growth. Thus trials were conducted to culture of hybrid ovules about 10days old, before the death of growing seed, after hybridization of Chinese cabbage and radish. The obtained hybrid plants, however, were alloidiploid that could not produce pollen and progeny. Therefore, allotetraploids were created by colchicine treatment. Because the allotetraploid might produce sufficient pollen, seeds could be obtained from self-fertilization. However, the number is too small to meet economical efficient as a crop. Also purity of the lines was so bad to be adopted as a new crop. Therefore, all the trials to create a new species by crossing Chinese cabbage and radish have ended up to failures in the past.

The objective of the present invention is to develop a new crop characterized in that can survive in the natural environment and have strong disease tolerance to virus, enough uniformity and high economical value as a crop by hybridizing Chinese cabbage and radish.
The other objective of the present invention relates to providing method for breeding said new plant obtained by crossing Chinese cabbage and radish.

DISCRPTION OF THE INVENTION

The said objective of the present invention was accomplished by the following processes; to hybridize Chinese cabbage cultivars "JUNSEUNG" as the mother and radish cultivars "BAEKKYOUNG" as the father, to culture 10 days old ovules in modified B5 medium to acquire alldiploid (amphihaploid), to induce allotetraploid from alldiploid by colchicine treatment on growing point, to culture of anthers on the another modified B5 medium for fixing the characters and to culture microspores in NLN13 medium to get fixed amphidiploid plants again which is named OAM1 later days, and to get OAM 1-2 from self-fertilization of the said individual which is named BAEMOOCHAE as a new vegetable crop.

Detailed description of process of the present invention is following.

The compositions of the present invention are:

The step of hybridizing Chinese cabbage "JUNSENG" as the mother and radish "BAEKKYOUNG" as the father and culturing the hybrid ovule prior to deterioration;

The step of acquiring F1 alldiploid (amphiploid) and performing colchicine treatment on the said;

The step of inducing into allotetraploid (amphidiploid) [pedigree number 115C];

The step of anther culture of the said 115C line;

The step of culturing microspore of OA20-1-10-1 line in NLN13 medium;

The step of producing OAM 1-2, a new crop, named BAEMOOCHAE by self-fertilization of said amphidiploid plant (OAM1) individually.
In more details, the present invent BAEMOOCHAE, a new crop is comprised of the following steps:

The step of hybridizing Chinese cabbage "JUNSEUNG" as the mother and radish "BAEKKYOUNG" as the father;

The step of culturing the ovule in modified B5 medium (manufactured by adding CaCl2·2H2O 600mg/L, NAA 0.1 mg/L, 2,4-D 0.1 mg/L and agar 8g/L, pH 5.8) to get hybrid plant (allodiploid);

The step of inducing allotetraploid (amphidiploid) by treatment of 0.3% solution of colchicine on the growing point to get the line number OV115C from the plant coded OV115;

The step of performing anther culture of said line number 115C for genetic fixation;

The step of culturing microspores of OA20-1-10-1 line gained from the said anther culture for further fixation of characteristics and acquiring amphidiploid (line name OAM1) plant individual; and

The step of acquiring a new vegetable crop, BAEMOOCHAE, from the seed produced by individual self-fertilization of said OAM1.

According to the present invention, the new plant BAEMOOCHAE of the present invention has such characters of strong disease resistance to virus and homogeneous quality that is appropriate for a crop.

The new species of plant, BAEMOOCHAE, of the present invention is a hybrid plant with uniformity by anther culture and by microspore culture.

The seed productivity of the BAEMOOCHAE of the present invention is beyond 300 pods per plant and 1.7 seed as average per pod.

Evaluated those results, though the number is still small by comparison, the seed productivity is economically sufficient.

The homogeneous quality of plants cultivated with the seed is high enough to be a vegetable crop.
The characteristics of BAEMOOCHAE in the present invention is following:

1. seeds
   shape: round shape
   color: dark brown

2. leaf
   color: green
   trichome: lot
   lobule number: 7
   midrib: round
   length: 45 cm

3. root
   characteristic: tap root
   length: 25 cm
   diameter: 5.0 cm

4. flower color: white

5. pod
   shape: upper part is radish-like and lower part is Chinese cabbage-like
   spongy tissue inside of pod: yes in radish-like part and no in cabbage-like part

6. the number of ovule per pod: 7-12

7. condition of floral differentiation: low temperature

8. self-incompatibility: no

The seed of BAEMOOCHAE in the present invention is the round shape, dark brown like Chinese cabbage. The size of seeds is irregular, some are smaller than the seed of Chinese cabbage and others are bigger than the seed of radish. However, the size of seeds has no relationship with the forms and growth of plants. The leaf shape of BAEMOOCHAE looks resembled with that of radish,
however, it is medium type of Chinese cabbage and radish. There are lots of lobules on the surface of the leaf and the midrib. The BAEMOOCHAE in the present invention has taproot resembled with turnip root in the shape, totally different from that of Chinese cabbage and radish. The pod of BAEMOOCHAE in the present invention is same as that of Chinese cabbage in the lower part and that of radish in the upper part, and both parts have seeds.

The characteristics of BAEMOOCHAE as a vegetable are following according to the present invention:

1. uniformity: homogeneous
2. plant weight: 2.0-3.0 kg
3. head formation: loose-head
4. color of inner leaf: yellow
5. disease tolerance to virus: strong
6. sowing time: mid-August
7. harvesting time: late October

BRIEF DESCRIPTION OF THE DRAWINGS

FIG 1 is a photograph that shows a seedling and an adult plant of the present invention BAEMOOCHAE

FIG 2 is a photograph that shows comparisons of leaves from the present invention BAEMOOCHAE (b), Chinese cabbage (a) and radish (c).

FIG 3 is a photograph that shows comparison of seedpod from the present invention BAEMOOCHAE, Chinese cabbage and radish.

FIG 4 is a schematic diagram representing breeding process of "BAEMOOCHAE"

In the following, the present invention will be explained in more detail with reference to the following examples. However, the following examples are provided only to illustrate the present invention, and it should be understood that the scope of the present invention is not limited thereto.
DETAILED DISCRIPITION OF THE PREFERRED EMBODIMENT

EXAMPLE 1: Breeding a new crop BAEMOOCHAE

The method for breeding the new crop BAEMOOCHAE is represented in FIG 4.

In detail, to obtain new species of plant BAEMOOCHAE in the present invention, Chinese cabbage F1 hybrid "JUNSEUNG" and radish F1 hybrid "BAEKKYOOG" were sowed and raised in greenhouse in Horticulture Research Institute in Rural Development Administration (RDA) on Oct, 1985. On the next year 1986, the hybridization of Chinese cabbage as the mother and radish as the father was performed in blooming season, from January to March. The growing ovules (immature seeds) were cultured in modified B5 medium (basic B5 medium +CaCl2·2H2O 600 mg/L + NAA 0.1 mg/L + 2,4-D 0.1 mg/L + agar 8g/L, pH 5.8) to obtain many hybrid plants at the 10th day after pollination. Since said plants were all allodiploid (amphimonoploid), allotetraploid (amphidiploid) was induced by 0.3 % colchicine solution treatment for 3 days on the growing point at the 4-5 normal leaves stage. Thereafter, self-fertilization was done on May-June and anther culture was proceeded with application of Keller and Armstrong(1960) 's anther culture technique with the plant coded OV115C which was selected for high bearing ability of pods in self pollination. As the result, the amount of seeds from self-fertilization was large in the individual plant OV115C, and 33 embryos were induced from anther culture. Said individuals were selected as a family line. When progenies of line 115C(S1 generation) were self-pollinated, 1.5 seeds in average were produced per flower. However, even after several generations, the characters were so unfixed that could not be a crop. The other individuals (the individual number starts with OA) obtained by anther culture of said 115C line were also unfixed in characters after succeeding generations. Therefore, microspore culture technique that had become general in early '90s was applied. Microspores of the line OA20-1-10-1 from anther culture was cultured in NLN13
medium, and obtained 9 individuals of the amphidiploid plant. The said was given line name, OAM., and the seeds were obtained by self-fertilization. The seeds of said line were sowed in the field to produce seeds and a result that about 300 pods per plant and 2 seeds per pod on the average was obtained. Moreover, plants grew on the field where seeds were dropped and remained. Therefore, the new crop BAEMOOCHAE that can survive in the natural environment like weeds and produce economically sufficient seeds and has acceptable uniformity was acquired.

The following table 1 shows botanic characters of the present invention, a new plant BAEMOOCHAE with comparison to those of Chinese cabbage and radish.

[TABLE 1]

<table>
<thead>
<tr>
<th>Crop</th>
<th>Seed</th>
<th>Leaf</th>
<th>Root</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shape</td>
<td>Color</td>
<td>Color</td>
</tr>
<tr>
<td>Chinese cabbage</td>
<td>Round</td>
<td>Dark brown</td>
<td>Light green</td>
</tr>
<tr>
<td>Radish</td>
<td>Oblate</td>
<td>Yellow brown</td>
<td>Dark green</td>
</tr>
<tr>
<td>BAEMOOCHAE</td>
<td>Round</td>
<td>Dark brown</td>
<td>Green</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color of flower</th>
<th>Pod</th>
<th>The number of ovule per pod</th>
<th>Condition for floral differentiation</th>
<th>Self-incompatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Ectomorph</td>
<td>No</td>
<td>25-28</td>
<td>Low temperature</td>
</tr>
<tr>
<td>White</td>
<td>Monotocous</td>
<td>Yes</td>
<td>4-6</td>
<td>Low temperature</td>
</tr>
<tr>
<td>White</td>
<td>Middle</td>
<td>No, yes</td>
<td>7-12</td>
<td>Low temperature</td>
</tr>
</tbody>
</table>

The following table 2 shows the characteristics of a new vegetable crop BAEMOOCHAE
[TABLE 2]

<table>
<thead>
<tr>
<th>Purity</th>
<th>number of leaves</th>
<th>Length of leaf</th>
<th>Weight of plant (kg)</th>
<th>Heading ability</th>
<th>Color of inner leaf</th>
<th>Resistance to virus</th>
<th>Sowing season for full cropping</th>
<th>Harvesting season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous</td>
<td>32</td>
<td>45</td>
<td>2.0</td>
<td>Loose-head</td>
<td>Yellow</td>
<td>Strong</td>
<td>Mid-Aug.</td>
<td>Late Oct.</td>
</tr>
</tbody>
</table>

**EXAMPLE 2**

New species of plant BAEMOOCHAE in the present invention was produced in large amount by cultivating shoot of BAEMOOCHAE or forming callus from vegetative tissues according to conventional tissue culture methods.

**INDUSTRIAL APPLICABILITY**

The present invention provides a new species of plant BAEMOOCHAE characterized in that can survived in natural environment and have strong disease tolerance to virus, sufficient seed productivity and is homogeneous by hybridizing Chinese cabbage "JUNSEUNG" as the female and radish "BAEKKYOUNG" as the male. The present invention has effect in providing such a new plant that it is a useful invention in the field of new plant development.
CLAIMS

1. A new plant BAEMOOCHAE being raised by sowing the seed from hybridization of Chinese cabbage "JUNSEUNG" as the mother and radish "BAEKKYOUNG" as the father, propagating by asexual reproduction of tissue culture and having following features:

1. seeds
   shape: round
   color: dark brown

2. leaf
   color: green
   trichome: lot
   lobule number: 7
   midrib: round
   length: 45 cm

3. root
   character: tap root
   length: 25 cm
   diameter: 5 - 7 cm

4. flower color: white

5. pod
   shape: middle
   sponge tissue: yes in upper part and no in lower part

6. the number of ovule per pod: 7-12

7. condition of floral differentiation: low temperature

8. self-incompatibility: no

9. purity: homogeneous

10. head ability formation: weak (loose-head)

11. disease tolerance to virus: strong

12. sowing season for fall cropping: mid-August
13. harvesting season: late-October

2. A breeding method of a new plant BAEMOOCHAE comprising the steps of:
   Hybridizing Chinese cabbage cultivars "JUNSEUNG" as the mother and
   radish cultivars "BAAKKYOUNG" as the father;
   Culturing ovules in the modified B5 medium (manufactured by adding
   CaCl2·2H2O 500mg/L, NAA 0.1 mg/L, 2,4-D 0.1 mg/L and agar 8g/L. pH 5.8) to
   get hybrid plant (allodiploid);
   Inducing allotetraploid (amphidiploid) by 0.3% colchicine solution
   treatment on the growing point to get the line code 115C, at the 4-5 normal leaves
   stage of the said alldiploid OV115;
   Performing anther culture of the said line # 115C;
   Culturing microspore of line OA20-1-10-1 from anther culture in NLN13
   medium to get amphidiploid (line name: OAM1) plant individual; and
   Producing BAEMOOCHAE with seeds gained from individual self-
   fertilization of said OAM1.
(♀) Chinese cabbage "JUNSEUNG" × Radish "BAEKHYOUNG"(♂)
(2n=2x=20) (2n=2x=18)
Culture of ovule on 10 days after fertilization
F1 allohexaploid (2n=2x=19)
Colchicine treatment on the F1 allohexaploid
Allotetraploid (2n=4x=38)
(Pedigree number 115C)

Self-fertilization
115C-4

Anther culture
OA20
OA20-1~10-1
Microspore culture
OAM1
Self-fertilization
OAM1-1 "BAEMOOCHE"
A. CLASSIFICATION OF SUBJECT MATTER

IPC7 A01H 5/00

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)

IPC7 A01H

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

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

eKIPASS, PubMed, NDSL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>

Date of the actual completion of the international search

25 MARCH 2004 (25.03.2004)

Date of mailing of the international search report

26 MARCH 2004 (26.03.2004)

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Form PCT/ISA/210 (second sheet) (January 2004)