

The Production, Distribution, and Utilization of Rice in Japan

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Introduction

In Japan having a climate of temperate monsoon, the paddy rice is the crop which is the most suitable for the paddy field, and demonstrates various functions such as maintenance of source of water supply and natural ecosystem and supply of the staple food. Since the National Agricultural Institute was established in 1893, the rice crop in Japan is always improved and yield per unit area became to about 2.5 times, and working hours became to about 1/6. Such a remarkable progress was made through new method of cultivation, developments of fertilizer, agrichemicals, cultivation technique, and mechanization, the formation of a large division of a paddy field, and maintenance of facility of irrigation water. The development of excellent varieties of rice played the important role for such a dramatic progress. Moreover, new types of rice cultivars are recently bred by the Ministry of Agriculture, Forestry, and Fishery of Japan. On the other hand, it shows a rising tendency that recent Japanese consumers utilize many rice based convenience foods such as processed rice and pre-cooked rice.

This paper introduces some of recent breeding and utilization of rice in Japan.

Recent rice breeding in Japan

Recent main cultivars in Japan

The top 10 rice cultivars that have spread in Japan are "Koshihikari" (35.5% of planted area, 2000), "Hitomebore" (9.7%), "Hinohikari" (9.0%), "Akitakomachi" (8.5%), "Kirara397" (4.8%), "Kinuhikari" (3.6%), "Haenuki" (2.7%), "Hoshinoyume" (2.6%), "Nipponbare" (1.3%), and "Tsurugaroman" (1.3%). "Koshihikari" cultivated in 1956 is a representative cultivar of a good taste, and is encouraged to be cultivated widely in 41 prefectures in Japan. Most of the present cultivars of tasty rice are this posterity. It has a cold resistance gene and a character to be hard to germinate in the state of an ear. The weak resistance for blast and lodging is the defect of "Koshihikari" variety.

It is presumed that planted area of " Koshihikari " and its blood relation varieties occupies about 90% of the whole planted area, and the importance of the tasty rice is recognized afresh. Therefore, cultivation of a single kind of cultivar, centralization of agricultural work tend to be carried out. Moreover, since the breeding of tasty rice was advanced, improvements of "resistance to lodging", "rice blast resistance", and many other characteristics are behind.

Target of rice breeding

Japan Island is long from the north to the south , it is located between China and the Pacific Ocean, and mountain ranges rise in the center, and the warm and cold currents are flowing around islands. These complicate geographical and weather conditions of Japan make the agricultural environment complicate. Now, The "transgenic rice" is expected to the important function and role for avoiding which crisis with insufficient nutrition and famine which will become serious in the future. In order to develop new cultivars and materials in the future, search and preservation of genetic resources, evaluation of the character, and cooperation internationally for related technical information etc. are thought to be important. Moreover, in order to success an epoch-making breeding it is important to develop the other research fields such as domestic genetic resources and biotechnology, physiology, quality, insect pests and weeds, soil manure, machine work, and food processing, and fundamental research.

New types of rice in Japan

Overproduction of rice started in the1970s brought the restriction of rice cropping in Japan, and the expansion of the demand for rice has been expected by the diversification of consumption of rice in Japan. The Ministry of Agriculture, Forestry, and Fisheries of Japan has started the project research "development of a new type of paddy field crops for expansion of demand"(the common name is "super-rice project") from 1989. The methods of utilization and processing of the new type of rice has been developed in close association with quality and breeding researches of rice in the project research. Moreover, it has planned that tap new market of rice by breeding new rice cultivars equipped with the new character corresponding to the use purpose.

The ingredients of the rice endosperm such as "amylose" and "protein", the shapes of grains such as "long grain" and "large grain", and the sense such as " aroma" and "color"

of rice are expected as the character variable for new utilization of rice. These breeding of new types of rice were performed by introducing the useful and purposive characters from foreign cultivars to Japanese ones, and producing mutants of new characters by radiation and chemical reagent of mutagenesis. These characters of new types of rice are expected to create new demands for rice, since they are suitable for the use different from the existent rice cultivars for staple food.

"Amylose variation rice"

Starch is the most important ingredient that occupies about 70% of "brown rice", and is composed of amylose (straight chain-like molecules) and amylopectin (branched molecules). Starch of "glutinous rice" does not contain amylose, but composed of only amylopectin, starch of "non-glutinous rice" consists of both of amylose and amylopectin, and the ratio of amylose to amylopectin strikingly influences to stickiness and taste of cooked rice. There is the range of amylose contents from less than 10% to more than 30% in foreign "glutinous rice." varieties. On the other hand, the range of amylose contents of Japanese varieties is about 17 - 23%, and the range is narrow compared with foreign "glutinous rice" varieties. Then, breeding of rice varieties with the amylose content beyond the range of the conventional Japanese ones has been advanced.

Amylose contents of 5 -15 % correspond to the middle values between amylose contents of "non-glutinous rice" and "glutinous rice". The rice of amylose contents of 5 -15 % is called "low amylose rice". Many mutant rice of low amylose are bred, and low amylose genes such as *dul-5* were discovered. Rice grains of amylose content of 5 - 9% may become cloudy like glutinous rice grains in appearance, and rice grains of amylose content of 10 - 15% may not become cloudy. "Low amylose rice" is a tasty rice which excelled the usual "non-glutinous (regular) rice" in stickiness as "cooked rice". Moreover, "low amylose rice" has the feature which cannot become hard easily, even if it gets cold after cooking rice, it is suitable to the "processed rice" such as "frozen cooked rice ball", "chilled sushi", and "retort pouched rice", "aseptic cooked rice". On the other hand, if "low amylose rice" is blended at a fixed rate to the tasteless rice, the stickiness of cooked rice increases, and "smell of glutinous rice" is few. Therefore, "low amylose rice" is attracted the attention as good blend rice. However, the amylose content of "low amylose rice" tends to be easy to change according to the temperature of a grain filling period. Therefore, in order to carry out stable production of "low amylose rice" of the

desirous amylose content, it is required to choose and grow the varieties adapted for the cropping area.

Rice of amylose content of 25% or more is called "high amylose rice". If amylose content in rice is high, stickiness of cooked rice will be lost, and it will go to pieces if it cools down especially. The long and slender "Indica rice" grains generally grown in Southeast Asia etc. tend to be high amylose content, and "high amylose rice" of more than 30% amylose content has been raised in process of the breeding introduced "high yield" and "resistance for disease" into Japanese varieties from the "Indica rice". Since these rice are hard and have little stickiness as cooked rice, it is not suited for a general taste for cooked rice. However, little stickiness of "curry", "pilaf", "fried rice", etc., the use to fermented products, such as "Miso" and "alcohol", and "rice vermicelli", "rice noodle" is also expected. Now, although the use of the "high amylose rice" in Japan is not as frequent as "low amylose rice", the expansion of demand by the food service industry is expected.

Other new types of rice

There are "colored rice", "protein variation rice", "aromatic rice", "giant embryo rice", "high- yielding rice", "large grain rice", "small grain rice", "lipoxygenase deficient rice", "sugary rice", "floury rice", "ornamental rice" as the other new types of rice. Various kinds of utilizations are expected by each character of new types of rice.

Utilization of rice in Japan

Processed rice

Rice processing in Japan will progress very much in respect of the diversity and quality of product, it will go into the time of quality improvement of the meal after the 1980s, the research and development of technology of processing and preservation towards the improvement in quality will progress further. Although there is the rice processing which uses unhulled rice and brown rice as raw materials, most of brown rice is milled and the milled rice is used as raw materials. In Japan, although the brewing and production of rice cake do not show a big change quantitatively from the viewpoint of the processing use of rice, the amount of product of processed rice shows remarkable increase. In 1995, 9,115,000 tons of rice was used for staple food as cooked rice, 490,000 tons for Sake wine fermentation, 233,000 tons for rice cracker and rice flour production

and 100,000 tons for Miso fermentation in Japan. There are the processed rice products, such as "pre-cooked processed rice", "steaming processed rice", "fermentation food using malt", "rice cake", "rice cracker", "confectionery used rice powder" and "puffed food", and "quick cooking rice", "rice porridge", and "brown rice processed goods", " food used an embryo and rice bran". And the "pre-cooked processed rice" includes "frozen cooked food", "retort pouched rice", and "aseptic cooked rice", and "chilled cooked rice", and "canned cooked rice", "dried cooked rice". These various kinds of "pre-cooked processed rice" products were manufactured with improved safety and convenience by means, such as freezing, retort, aseptication, canned packing, and dryness.

Processed rice using unhulled rice

There are the "parboiled rice" in South Asia, the "converted rice" developed in the United States, and a Japanese traditional "roasted rice" as the processed rice using unhulled rice.

"Parboiled rice"

"Parboiled rice" is the processed rice made in Asian countries, especially India and its neighborhood for many years. After soaking the unhulled rice in water for one day and draining off the water, it is steamed for about 30 to 60 minutes, and dried by heat or sunlight, and hulling and milling are carried out. Since starch will gelatinize by heating and the endosperm will become hard by dryness, crushed rice is decreased, it is hard to be damaged by the insect or mold. Moreover, water-soluble ingredients, such as vitamin B₁ contained in bran layer or the embryo, shift into the endosperm, and the nutritional value of milled rice becomes high. However, there is a problem that milling rice becomes light yellow brown and the smell also becomes bad.

"Converted rice"

The fault for color and smell of "parboiled rice" have been improved, processing efficiency was raised, and it was developed in the United States during World War II. By using decompression operation for a processing process, processing time can be shortened remarkably and the yield of rice milling was also improved. Moreover, the almost white product without smell is obtained.

"Roasted rice"

Although it is thought that "roasted rice" was widely distributed over the rice-cropping region for many years in Japan, it is also made at present for private use at some farmers. "Roasted rice" is made using unripe "unhulled rice" at the season of the harvest in autumn "rice seed" which remained at the season of sowing in spring. After soaking "unhulled rice" fully, it is drained off the water by removing to a colander, and parched the "unhulled rice" by putting it into the iron pot which has already heated this directly, until heat permeates enough to the central part of "unhulled rice. Parched "unhulled rice" is moved to a mortar, and while it is hot, it is drummed with a mallet. If it is preserved for a long time, it should be dried and eating, it is parched once again for eating. Now, it is parched by the iron pot of a rotation drum, and high-quality "roasted rice" is manufactured using the thresher. Deoxidization material is used for preservation.

Processed food using "brown rice"

Many functional ingredients, such as a fiber, a mineral, vitamin, and lipid, are contained in "brown rice", and it is mainly used by the consumers concerned about the good health in Japan. Although it is necessary to use a pressurization iron pot for cooking the "brown rice", the puffed "brown rice" can be also cooked with a common rice cooker. In addition a "brown rice tea" is made by parching after adding a little more moisture.

"Bread made of whole rice flour"

When the dough of bread is made, "brown rice powder" of 10 -20% of wheat flour is generally added to wheat flour. Now, it is an enriched nutritional food utilized the nutritional value for "brown rice".

"Brown rice powder"

"Brown rice powder" are made by parching and milling of brown rice, or by milling the brown rice which dried after steaming. It is added to various wheat products such as bread, noodles, confectionery, and cakes, or is used as a "brown rice drink". Consumption of these products is increasing by consumers interested in good health.

Processed food using the "rice flour"

There are many kinds of "rice flour" in Japan, and it is called by various names according to materials, processing methods, characters, and uses. There are two types of "rice flour" which uses "non-glutinous rice" or "glutinous rice" as raw materials. There are also two types of "rice flour" which grinds the rice in the raw state or grinds after gelatinizing the endosperm starch by steaming or parching. They are classified to the "rice flour" manufactured from "non-glutinous rice" is called "Jyoshinko", "rice flour" from glutinous rice are called "Siratamako", "glutinous rice powder ("Mochiko")", "Kanbaiko", "Rakuganko", "Domyojiko", etc. Each "rice flour" has each character, and is used for respective use.

"Non-glutinous rice flour" ("Jyoshinnko")

After washing non-glutinous rice in cold water, water is removed, dried, sifted out, and packed as a product ("non-glutinous rice flour" ("Jyoshinko")). Especially, the product of fine particle size is called "Jyoyoko". "Non-glutinous rice flour" with a large particle size is used for rice cake, and "rice flour" with a fine particle size ("Jyoyoko") is used for high-class Japanese sweets.

"Glutinous rice flour" ("Siratamako")

"Glutinous rice flour" ("Siratamako") is made from milling of the "glutinous rice" in the raw state. After washing "milled glutinous rice" in cold water, it is absorbed fully the water by soaking and drained off water, ground with a stone mortar, passed through a sieve, dried and packed as a product. "Glutinous rice flour" is used to "rice flour dumpling", "rice cake sweets", "rice cake stuffed with sweet beans" ("Daifukumochi"), etc.

Rice milling

Now "rice milling" is performed commercially for the staple food and the sake brewing in Japan. Hulling is generally performed by farmers, and "brown rice" is shipped to the milled factory. The rice milling for the staple food is carried out by the milling system employed pressure, and the rice milling of "brewers' rice" is by the grinding system.

"Pre-washed rice" ("Musenmai")

"Pre-washed rice"("Musenmai") is the rice can boiling the rice without washing, and attracts attention in recent years in Japan. Since oxidization is slow and there is no adhesion of rice bran, and "pre-washed rice" is preservative and the condition of cooked rice is uniform. Since water for washing does not come out, it can avoid environmental pollution. Since labor force and cost of water can be saved, it also economically excels in the food service industry. The manufacture method of "pre-washed rice" has the old methods of taking rice bran with a brush, and blowing away rice bran by the air current, recently the method of taking rice bran by lipid and adjusting moisture after washing rice for short time with water is developed. Since the daily time and effort for washing rice can be saved by using "pre-washed rice" for not only ordinary homes but rice processor manufactures. The "pre-washed rice" is expected to be more important product in future.

Processing of noodles

"Rice noodle"

"Rice noodle" is the rice product newly developed against the background of the overstock of the rice of the 1970s in Japan. The "rice noodle" of 100% rice powder is kneaded about 10 minutes adding the water to "non-glutinous rice powder" with heating with a machine, and adds about 30% of "raw rice powder" to it and rolls, and makes band of noodle of the shape of same sheet as Japanese noodles, and is cut. The "raw rice noodles" is made to harden in a refrigerator. It becomes delicious "rice noodles" after boiling. The "rice noodles" with such a process is peculiar to Japan.

Confectionery

"Rice cracker"

There are the "rice cracker" made from "non-glutinous rice" or "glutinous rice" in the Japanese traditional confectionary used rice as materials. Now, although it is also exported to overseas, there is also much amount of import from Asian countries, and it is becoming international goods.

"Rice cake"

"Rice cake" is mainly eaten as a kind of preserved food in the New Year in Japan, and it became impossible to eat it once in warm season, since mold sprang up immediately it.

Packing rice cake appeared around from the 1960s in Japan, and preservation period of rice cake was strikingly extended. Therefore, became the goods can use all year around now. Although there were the "rice cake in vacuum package" which has only a preservation period for about two weeks before, and "packing rice cake" which carried out heating sterilization above 90 °C, delicious "rice cake" is a main product of rice cake, and there is "retort single packed rice cake" using the deoxidizer, "sterile packing rice cake" packed in a sterile condition, and "rice cake", and carried out retort sterilization now. Although "glutinous rice" is widely eaten in southern China and the Indochina Peninsula as "rice boiled together with red beans" and "rice cake", rice cake is made in large quantities at the factory in only Japan.

"Snack confectionery"

When it is momentarily returned to atmospheric pressure from hot and high-pressure conditions, the starch in cereal material will gelatinize and the volume expands rapidly and the tissue of cereals is destroyed, since the moisture changed to steam by the rapid fall to atmospheric pressure. The puffed food such as "snack confectionery" is produced by seasoning for the manufactured puffed materials.

Traditional rice cooking

"Rice porridge"

"Rice porridge" is the fluid rice cooking which added many water to milled rice, and has been conventionally used as sick person foods, a baby food, etc. in Japan. However, it passes smoothly through a throat, easily is digestible, and many products have also come to be made as healthy foods of a low calorie now. Recently many kinds of "rice porridge" are sold as a convenient food in a convenience store.

"Rice gruel"

"Rice gruel" is a kind of rice porridge which added vegetables, chicken, fish and shellfishes, etc. and cooked with broth. It is made in many cases using the remnants of boiled rice and soup in a pan in daily life. If "Indica rice" instead of Japonica rice are used, the rice gruel of the plain taste without stickiness will be made.

"Rice steamed with vegetables" ("Takikomigohan")

"Rice steamed with vegetables" is a cooked rice which added various ingredients, such as chicken, fish and shellfishes, vegetables, and mushrooms, to rice and boiled. There are many kind of "rice steamed with vegetables" in Japan, because the Japonica rice with moderate stickiness is harmonious with various foodstuffs in all seasons at different places in Japan.

"Sushi"

One of the most famous traditional rice based convenience foods in Japan is "sushi". "Sushi" is a general term of food arranged seafood toppings on the "sushi rice" which added vinegar taste to boiled rice. Sushi originated as a preservative food for fish using natural fermentation ("Narezushi") with the cooked rice being used as the substrate along with salt for *Lactobacillus* bacteria. "Nigirizushi" was developed in Tokyo in the 1800's as an easy to prepare rice dish, made by pressing a cooked rice ball manually and topped with sliced raw fish. Soy sauce and grated horseradish ("Wasabi") are necessary to enjoy the original taste of "sushi".

Pre-cooked processed rice

The popular of latest "pre-cooked processed rice" in Japan is based on the diversification of the kind, the improvement of flavor of "frozen processed rice" which are represented by "frozen roasted cooked rice balls" and "frozen pilaf", and the convenience and good taste of "aseptic cooked rice". Now, the amounts of production of "cooking processing rice" is getting to increase with competing violently in respect of diversification, convenience, the improvement in flavor and quality, etc in the food industry.

"Retort pouched rice"

"Retort pouched rice" was developed in 1973 in Japan. It is one of pioneering processed rice products. Rice and water are packed in a laminated plastic container and pasteurised at 120 °C for 4min. To consume the product, purchasers can either soak it in hot water for 15 min or heat it in a microwave oven for 1 min. The shelf life of this product is half a year without refrigeration and the price is reasonable. The problems with this product are off-flavors developed by the excess heating and texture of the cooked rice grains. Twenty two thousand tones of retort rice was produced in Japan in

1996.

"Frozen cooked rice"

"Frozen cooked rice" freezes quickly the rice which carried out cooking processing at the temperature of °40 or less, and saves it at the temperature of °20 or less. The market for frozen cooked rice in Japan expanding to 138,000 tons in 1996. Frozen cooked rice is convenient to cook in a microwave oven and its high quality is preserved in a freezer for a long period. It is a rather expensive product but frozen roasted cooked rice balls or frozen pilaf is very popular with Japanese consumers.

"Chilled cooked rice"

"Chilled cooked rice" is a product preserved in the state of refrigeration after packing the cooked processing rice. It is primarily developed as business use, but it is sold as the chilled boiled rice with the packed lunch in convenience store and supermarket, and utilized at present mainly by a single man and business bachelor need a small amount of boiled rice.

"Aseptic cooked rice"

"Aseptic cooked rice" was marketed from 1987 in Japan. Rice grains are washed well to remove any bacteria followed by cooking and packing in a clean broth. As contamination by microorganisms is very low, this product can be stored for half a year under natural room conditions. As the rice is not heated excessively during production, the eating quality of the final product is very good.

"Dried cooked rice"

"Dried cooked rice" is a product dried by the hot wind, after boiling the rice, and it was made in large quantities as military foods in 1944. Now, the method of producing "dried cooked rice" is improved and the high quality products without the smell by dryness during preservation is made using the tightly packed materials and deoxidation materials. Although the rice with little stickiness is generally suitable for processing, it became to be able to be made out of sticky and tasty rice. It is the feature of "dried cooked rice" to become delicious boiled rice in about 20 minutes by putting in hot water. It is used as "take out foods", such as mountain climbing, as a light "simple food" of

those who enjoy traveling abroad and an outdoor life, and as "emergency provisions" at the time of a calamity.

"Quick cooking rice"

Recently, pre-gelatinized and packaged rice without excess drying has been developed in Japan ("Quick cooking rice"). "Quick cooking rice" is one of processed rice heat-treated in advance by microwave etc. and various "quick cooking rice" which shortens cooking-rice time is made. Tightly packed material and deoxidization material are used for preservation. However, there are variations of quality for products, since it is made under various moisture conditions. Consumers only have to add to the envelope tasty cooking soup or water and cook for about 15 minutes. They can omit the time-consuming processes of washing rice, soaking and keeping it warm after cooking. Compared with "instant rice", "quick cooking rice" has improved taste and texture. Although its moisture content is more than 35%, it can be stored for several months without refrigeration by pasteurisation or by using an oxygen absorber.

Fermented rice goods

"Sake"

Manufacture of "Sake" begins from choice of rice fitted brewing. In order to make good alcohol, "brewers' rice" suitable for brewing is used. Since many ingredients which makes the tastes and scents worse, such as protein, unsaturated fatty acid, and iron in alcohol, are contained in the outer layer of rice grains, about 30% of outer layer of milled rice as raw materials in order to product the Sake is shaved off (It is about 9% for a common "milled rice for boiled rice"), and about 40% or more for "high-class sake".

"Miso"

"Miso" divides roughly into "rice Miso", "wheat Miso", and "beans Miso". The "rice Miso" is made overwhelmingly now. The raw materials of "rice Miso" are "soybean", "rice", and "salt", mainly, the protein and lipid of a "rice Miso" are served from a soybean and carbohydrate of it from rice. The "Miso" becomes to be sweet with high portions of rice.

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일본의 쌀 생산, 유통 및 이용현황

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일본은 기후적으로도 쌀의 생산에 적합하며 쌀은 일본의 주곡이다. 1893년 국립농업연구소가 설치된 이래로 쌀은 품질과 단보당 생산량이 꾸준히 개선되어와 1/6의 노동시간으로 생산량은 2.5배의 증가를 가져왔다. 이러한 진전은 재배방법의 개선, 비료, 농약, 재배기술, 기계화, 관개배수, 농지개량 등의 요인들로 볼 수 있다.

현재 일본에서 생산되고 있는 주요 쌀 품종으로는 코시히카리(35.5%), 히토메보레(9.7%), 히노히카리(9.0%), 아키다코마치(8.5%), 키라라(4.8%) 등 10여 품종이며 최근에는 형질전환 품종의 연구와 함께 생물공학적인 연구, 생리, 품질, 곤충과 잡초, 토양, 식품가공 등 기본적인 연구에 심혈을 기울이고 있다. 새로운 형태의 쌀 품종으로는 냉동조리쌀밥, 초밥, 레토르트용 쌀 등 가공용으로 적합하도록 하기 위하여 아밀로오스의 함량을 5-15%로 낮춘 쌀이나 카레, 필라프, 튀김 쌀 등의 용도에 적합하도록 아밀로오스의 함량을 30%이상으로 높인 쌀 뿐만 아니라 곡립의 크기와 길이 등을 변형시킨 쌀, 유색미, 향미(香米), 단백질 함량 조절 쌀, 거대 배아미, lipoxygenase 활성을 없앤 쌀, 단맛나는 쌀 등이 연구, 생산되고 있다.

일본에서의 쌀이용은 먼저 가공용 쌀을 들 수 있다. 밥, 청주, 스낵, 쌀가루, 미소발효 등 다양하게 이용이 되고 있으며 parboiled rice와 이의 색과 향을 개선한 converted rice, 현미를 이용한 가공쌀, 쌀빵, 현미가루, 세척미, 쌀국수, 쌀스낵, 당과, 죽, 삶은 채소아 함께하는 타키코미고한, 초밥, 냉동쌀밥, 무균포장밥, 건조밥, 즉석밥 등 매우 다양하다.