

Development of “Hanaomoi”: An Original Variety of Aomori Rice Suitable for Japanese Sake Production

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In order to develop a new variety of rice that adapts to the climate of Aomori prefecture and possesses characteristics suitable for production of high quality Japanese sake, artificial cross experiments were executed between Yamadanishiki, which is widely used nationwide as an authentic variety of rice for sake production, and Hanafubuki, which was previously developed by Aomori prefecture. An excellent hybrid, named Hanaomoi, was selected and fixed by a series of selection experiments and systematic cultivation. Unpolished Hanaomoi rice contained less amount of protein than Yamadanishiki and Hanafubuki. Unpolished rice of Hanaomoi was harder than Yamadanishiki and Hanafubuki, therefore polishing treatment was done in high yield and one could obtain a high degree of polish on the rice (namely 40% polishing). These features are advantageous to production of high quality of sake.

Test brewing using 40% polished Hanaomoi gave rise to a characteristic sake that contained a slightly higher amount of alcohol and flavor components than Yamadanishiki and Hanafubuki. Sensory tests concluded that sake from Hanaomoi was as superior as the one from authentic Yamadanishiki. Hanaomoi is a promising variety of rice suitable for production of a high quality sake exclusive to Aomori prefecture.

1. Outline of the Sake Brewing Process

Rice has always been staple of Japanese diet. Rice is roughly divided into two types: one is ordinary table rice that is eaten in daily life and another is called sakamai, special rice exclusively used for Japanese sake production. Japanese Sake can be made from ordinary table rice however one has to start from sakamai in order to make high grade of Japanese sake. Sakamai possesses characteristic features such as large and soft grains and are cultivated in limited regions with complex manner. Therefore, sakamai is dealt with higher price than the table rice.

The sake production in Japan was started after the cultivation of rice was introduced in the third century B.C., and the first written document appeared as old as 300 A.D. Since then, the sake has played important role for Japanese people as a part of life and culture. During the course of its history, the knowledge and the skill with respect to the sake production have been accumulated and distributed to nationwide.

The sake production requires only four ingredients: rice, water, yeast, and a mold known as Koji-mold. The rice is the most important material. In order to make high quality of sake, one has to secure appropriate sakamai. The Sakamai is carefully and gently polished. The degree of polishing is very crucial and greatly affects the quality of the final product. The premium sake is made from special sakamai, in which the starch matrix, called the Shinpaku, is concentrated at the center of the grain. The proteins, the lipids, and the amino acids are localized in outer part of the grain. To increase the degree of polishing, one can remove these components that may cause unfavorable flavor and taste. This degree of polishing is particularly called the Seimaibuai. The Seimaibuai is expressed as the proportion of remaining part of the grain after polishing. When the Seimaibuai is 60%, 40% of the grain is at least polished away. The sake is classified to three categories according to the Semaibuai: Junmai-shu and Honjozo-shu (Seimaibuai 70% below), Junmai-Ginjo-shu and Ginjo-shu (premium sake, Seimaibuai 60% below), and Junmai-Daiginjo-shu and Daiginjo-shu (super premium sake, Seimaibuai 50% below). One can produce higher quality of sake when the rice is more polished.

The rice after polishing is cautiously washed and then soaked in water to reach a certain water content. The rice is steamed in different way from the case of ordinary table rice.

The sake brewing starts from the introduction of the Koji. The steamed rice that has been colded to appropriate temperature is transferred to a special room. The spore form of the Koji-mold, a kind of fungi, is sprayed on the steamed rice, and the Koji-mold is developed on the rice in the Koji room. The Koji making step, so-called the saccharification step, the rice starch is decomposed to glucose. This is a laborious step over 48 hours under high temperature and high humid conditions.

The yeast starter, called the Shubo, is another important step along with the Koji in sake production. The Shubo comprises the steamed rice and the Koji prepared in above two steps with water and the controlled concentration of the yeast cells. The yeast is allowed to propagate in two weeks. The Shubo is then moved to a large tank, and three successive portions of the steamed rice, the Koji, and water are added in four days, which give arise the main mash, called the Moromi. This process is continued for about 20 days. The parameters such as temperature are carefully monitored during the course of fermentation. In the Moromi, the saccharification by the Koji-mold and the fermentation by the yeast are simultaneously taken place. This process, called the multiple parallel fermentation, is peculiar to the sake production and distinct from other brewing process such as beer and wine.

When the Moromi is matured, it is pressed and squeezed by several methods. The white residue, sake lees, is removed to give arise the fresh sake, which is then settled and filtered through charcoal to adjust its color and flavor.

Most of the cases, the fresh sake is quickly pasteurized by passing through spiral tube at 65oC. This procedure kills bacteria and deactivates enzymes that would spoil the flavor and color of the final product.

After going through these steps, the sake is aged for one month to several years, and its alcohol content that is usually near 20% should be adjusted to about 15% by adding pure water before shipping.

Recent trend shows that the consumers demands would match high quality of sake, namely Ginjo-shu or Daiginjo-shu that has light and fruity taste along with aromatic flavor. The brewers have to employ special sakamai, suitable for high degree polishing that would provide high quality of sake.

Yamadanishiki is one of the most representative and authentic sakamai among many other varieties. According to the statistics in 2003, Yamadanishiki is cultivated in 5,319 ha mainly in Hyogo prefecture. This area is corresponding to 32% of eitre sakamai production in Japan.

However, Yamadanishiki is grown under relatively warmer climate, therefore, it has been required to develop a new variety of sakamai that can be resistant to cold climate such like Aomori prefecture and that are suitable for high degree polishing so as to produce good quality of sake.

2. Development of the AKS140

Aomori prefecture began to study on development of its own sakamai that can be grown in cold climate in 1959. The first variety called the Kojonishiki was developed in 1968. The Kojonishiki was then crossed with the Reimei that were one of the representative cold-resistant variety of rice to give the variety called Hohai in 1976. On the other hand, the Okuhomare was developed from the Reimei in 1986, and the Okuhomare was soon improved in 1987 to give the AKS97, expressing the 97th candidate for the variety of sakamai in Aomori prefecture. The AKS97 was later given a trivial name Hanafubuki. The Hanafubuki is currently cultivated mainly in Aomori prefecture. The Hanafubuki acquired a certain reputation for Junmai-shu production (Seimaibuai 70% below), however, the Hanafubuki grains suffer cracking when it is subjected to high degree of polishing such as Seimaibuai 50% below because the Hanafubuki has the large and fragile Shinpaku. Therefore, Aomori prefecture has to depend on the sakamai from other prefectures for brewing premium grade of sake Ginjo-shu and Daiginjo-shu. Development of Aomori own sakamai has been long waited.

In 1987, Aomori Prefectural Agriculture and Forestry Research Center carried out an artificial cross experiment in which pollen from the Hanafubuki was inseminated with a pistil of the Yamadanishiki. After the F1 generation was forced to grow in a greenhouse during winter in 1987, the selection and improvement experiments were repeated in the experimental farm for seven seasons by 1993. However, any strains that possessed adequate quality and resistance for pathogens were not obtained. In 1994, 504 grains out of 3,500 grains that have been stored in 1989 were selected according to the size of the Shinpaku suitable for high degree polishing. After seedling experiments, 206 strains were obtained, and 75 strains were then selected. Finally 47 strains were chosen by the criteria such as feasibility for high degree polishing, resistance for pathogens, and suitable properties for cultivation. And they were subjected to brewing experiments in 1998.

Forty seven candidates and Yamadanishiki as the reference were compared with respect to 40 items such as moisture, hardness, protein content, cracked ratio, and so on. Furthermore, these samples with Seimaibuai 40% were subjected to 100 g scale brewing test and brewing properties were compared. As results, a single strain was selected due to some advantages like its resistance for cracking while high degree polishing as Seimaibuai 40%, easiness of handling for rice washing, good steaming results, good affinity with Koji mold, good combination with yeast, good balance while low temperature fermentation, good progress of Moromi, and good total taste of the final product. This strain was numbered AKS140.

3. Properties of the AKS140

Cultivation properties of the AKS140 were compared with the leading variety Hanafubuki. The characteristics of the AKS140 as a plant were following: ear forming was later than the Hanafubuki, and the height of plants were about the same as the Hanafubuki. The AKS140 had thick stems therefore it had resistance to falling. The yield of the AKS140 was lower than that of the Hanafubuki. The weight of 1000 grains of brown rice was slightly lighter than the Hanafubuki, indicating the AKS had smaller grains. The quality of the brown grain was better than the Hanafubuki. There were many appearance of the Shinpaku with point or line shapes. However, the AKS140 was found to be susceptible to the rice blast pathogen. The AKS140 was cold-resistant like the Hanafubuki.

The AKS140 was subjected to the standard analyses for sakamai. Values of unavailable ratio, cracked rice ratio, digestible formol-nitrogen, and crude protein were appeared to be low, therefore the AKS140 was judged to be high quality. However, moisture adsorption and potassium content were unfavorable.

Chemical components and the Shinpaku area of brown rice of the AKS140 were analysed in comparison to the Yamadanishiki and the Hanafubuki. The AKS140 contained less amount of crude protein than the Yamadanishiki and the Hanafubuki. The AKS140 contained more mineral components such as Fe, Mn, Ca, and Mg than the Yamadanishiki and the Hanafubuki. Percentage of the Shinpaku area of the AKS140 was smaller than the Yamadanishiki and the Hanafubuki, indicating the AKS140 were suitable for high degree polishing.

The characteristics of the AKS140 as a plant were inherited from the Hanafubuki in which the height of plants is shorter than the Yamadanishiki and therefore resistant to falling, whereas the characteristics of the AKS140 as sakamai were inherited from the Yamadanishiki in which it showed low cracked rice ratio during polishing, appropriate mineral contents, and low protein content. These features were suitable for production of high quality sake.

4. Test Brewing using the AKS140

Large scale brewing test using the AKS140 crop in 2000 was carried out by Hirosaki Technical Laboratory in collaboration with five local brewing companies. The Yamadanishiki or the Hohai were used as references. The AKS140 as well as the reference rice were polished to Seimaibuai 40%. It was up to each factory whether they intended to produce Junmai-daiginjo-shu or Daiginjo-shu by addition of brewed alcohol.

As results, there were less broken grains in the AKS140 than the Yamadanishiki during polishing steps. The AKS140 showed slower absorption of water than the Yamanishiki. During washing and soaking steps, there were only small amount of cracked grains. Streamed AKS140 was harder than the Yamanishiki but it was well handled and did not cause any problem. There was no significant difference in enzyme activities of the Goji between the AKS140 and the reference. The Shubo from the AKS140 was less viscous than references and the Shubo making proceeded well except the AKS140 gave slightly lower density. The Moromi from the AKS140 showed less digestibility than references. The taste and body of the AKS140 Moromi was slightly unfavorable than references, however the AKS140 Moromi gave better density and

tended to result shorter Moromi period than references. General ingredients, free organic acid, and aromatic components of the final products were analyzed. As results, the AKS140 contained higher sake meter than references. There was essentially no difference in free organic acids between the AKS140 and references. The AKS140 contained more aromatic components than references. In total, the AKS140 gave arise high quality of sake in which it produced fine taste and good combination of flavor.

5. Perspective

Given the results described above, the AKS140 was officially resistered as a promoted variety by the prefectural authority and a trivial name Hanaomoi was given in spring 2002. Commercial production of Ginjo-shu using Hanaomoi has began in 2002. In fall 2002, the Hanaomoi was harvested by the contract farms and they were distributed to 20 factories of 18 brewing companies in Aomori prefecture in addition to Hirosaki Technical Laboratory. The Hanaomoi was used for Daiginjo-shu production by their own techniques in each brewers from winter 2002 to spring 2003. The Daiginjo-shu aged over summer 2003 will be offered to the sensory test this October and the excellent products will be allowed to label the brand name Hanaomoi as a trade mark.

On the other hand, Hirosaki technical laboratory has been dealing with research on development of yeast and Koji-mold suitable for Hanaomoi by applying advanced biotechnology, and some of the results have been already obtained. When these studies are accomplished, all the ingredients, sakamai, yeast, and Koji-mold are original and genuine so that they are exclusively used in Aomori prefecture. Then the primary purpose to produce competitive and high quality sake will be fulfilled.

As a consequence, cultivation area for the new variety of sakamai is increased. and it became possible to produce large amount of highly added valuable rice in Aomori prefecture. This leads to vitalization in the agricultural field. In addition, it became possible for sake brewing companies to provide new merchandise with high quality and high profit using local sakamai. Success of Hanaomoi woill produce great deal of influence on distribution industry and tourism as well as food related industy, It promises to activate the entire regional economy.