DISTINCTION OF MIXED WATER YAM'S STARAINS (*DIOSCOREA ALATA* L.) CULTIVATED IN YAKU ISLAND

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Abstract

This study clarified we could effectively distinguish mixed water yam strains by observing the differences of morphology of the leaves and tubers in Yaku Island. However, there are considerable variations in morphology, so we may be able to more confidently distinguish strains by also employing the electrophoresis method using acetone powder.

Key words: Mixed strains, Polyacrylamide gel electrophoresis, Water yam, Yaku Island

Introduction

What are generally called Yam in Japan are mostly Chinese yam (*Dioscorea opposita* THUNB., Naga-imo) or Japanese yam (*D. japonica* THUNB., Yamano-imo or Jinen-jyo), and both species are originally from temperate zones. However, among some 600 species of the *Dioscorea* genus plants (to which yam belong) said to exist worldwide, about 10 species are used for economic cultivation, most of which are originally from the tropical or subtropical zones. One of them, *D.alata,* or water yam in English, is called 'Daijyo' in Japan. It is supposed to have originally come from Southeast Asia, but now can be found widely in Asia, Oceania, Africa and Central America. In Japan, it is cultivated in warm districts in the southwest and is mainly eaten uncooked or processed into sweets and buckwheat noodles.

Farmers in Yaku Island, Kagoshima prefecture, started economic cultivation of water yam in the town of Kamiyaku in about 1986. Some 18 hectares are now cultivated in both the town of Kamiyaku and Yaku, and the cultivated area is increasing. A storehouse and a processing factory were built in the town of Kamiyaku in 1992, and today, water yam is processed into grated yam, frozen, and shipped in 100g packs throughout the year.

The cultivated strain "Solo Yam", which Kagoshima University introduced from Indonesia, is used because of its high viscosity and good taste (ISHIHATA et al., 1977, 1984). However, as the years under cultivation and the cultivated area increased, other strains were mixed with "Solo Yam" in cultivation. Compared to "Solo Yam", these strains have extremely low viscosity and change colors easily during processing and have thus caused some problems in producing grated yam.

The authors previously reported that morphology, the RAPD method (SHIWACHI et al., 2000), and tuber protein are effective methods for distinguishing water yam strains (ONJO et al., 1995). In this study, we investigated whether it was possible to distinguish mixed strains in Yaku Island, using comparatively easy and cheap morphology and tuber protein.

Materials and Methods

Tubers were harvested, collected and stored at 15℃ in a storehouse in the town of Kamiyaku

in December 2000. Nine tubers that differed in shape by the naked eye were chosen in February 2001 and used as samples in this experiment. First, the weight, width (maximum and minimum), and length of each tuber were measured. We then hollowed out the center of the tubers, measured water percentage and produced acetone powder. The water percentage of the tubers was determined by drying about 10g of fresh tubers at 120℃ for 72 hours and then measuring the weight of the dried tubers. Next, the tubers were cut into 50 to 70g samples, sterilized them by a normal method, and then planted them in 10-liter cloth pots on May 10, 2001. We kept only one of the sprouted stems and cut the rest off. The selected stem was then trained onto a 1.2m prop. Following the standard given by Breeding Department of National Research Institute of Vegetables, Ministry of Agriculture, Forestry and Fishery (TAKAYANAGI et al., 1984), we investigated the morphological characteristics of the top on September 1, when it was a good growing season.

Acetone powder was produced as follows. We put about 15g of fresh tuber into an appropriately cooled nyubachi and quickly smashed it while pouring on acetone that had been cooled down to -20℃. It was then filtered and dried to obtain acetone powder and the powder was stored at -20℃. The amount of powder obtained is given by the weight % of powder to the weight of the smashed fresh tuber. With this acetone powder, we tried to distinguish the mixed strains using polyacrylamide gel electrophoresis. In both investigations, we used "Solo Yam" preserved and subcultivated by Kagoshima University as a control and tried to distinguish the mixed strains by comparing them to the nine tuber samples from Yaku Island.

Results and Discussion

1. Morphological and physiological characteristics of the top and the tuber

Table 1 shows the result of the morphological characterization of the top. No clear differences were observed among individuals in growth of stems and all parts above the ground. However, two samples, Y7 and Y8, did not exhibit the coloring of anthocyanin on the wing part of the stem, one of the characteristics of water yam. This anthocyanin coloring can be used as an indicator to distinguish the water yam's strain (SHIWACHI et al., 2000). It was therefore presumed that Y7 and Y8 were not "Solo Yam." We next looked at the morphology of the leaves. Although it was observed considerable differences among individuals for each investigation item, but there was no constant tendency. However, observing with the naked eye, it is noted that the leaf of "Solo Yam" was heart-shaped whereas those of Y2, Y7 and Y8 were wedge types. Measurements confirmed that only Y2, Y7, and Y8 leaves had widths of less than 7cm and shoulder widths of more than 4cm.

Tables 2 and 3 show morphological and physiological characteristics of the tubers. The flesh color of the tuber, color changes in cutting and viscosity vary to some extent according to the cultivation or storage conditions. The flesh color of the tuber and viscosity was thought to be within this variation. However, the color changes were remarkable in Y2, Y7 and Y8 and were considered to be bigger than the variation due to the conditions above. It was therefore possible that this was due to the characteristics of each individual. Next the tuber shapes were compared. The length/width ratios were large in Y2, Y6, Y7 and Y8, which were long and thin compared to "Solo Yam." Water percentage of the tubers and the collection rates of the acetone powder differed in each individual.

2. Distinction by polyacrylamide gel electrophoresis

Fig. 1 shows the result of polyacrylamide gel electrophoresis. Y1, Y2, Y4, Y5, Y6 and Y9 appeared to be the same type as "Solo Yam" when detected band patterns were compared. However, a band that was not seen in "Solo Yam" was detected in Y2, Y7 and Y8 (arrows in Fig. 1). We hence

assumed that proteins in the tubers were different. From electrophoresis results, Y2, Y7 and Y8 would be different strains.

Judging generally from the results above of morphological, physiological and electrophoresis methods, we considered samples Y2, Y7 and Y8 to be of different strains.

Table 1-1. Morphological characters in 9 samples of cultivated yams collected from Yaku Island (Continued over).

Sample No.	Plant vigor	Type of branches	Stem			
			Type of twining	Shape of cross section	Diameter (mm)	Wing Color
Y1	3	5	2	2	2.6	2
Y2	3	3	2	2	2.5	2
Y3	5	3	2	2	2.9	2
Y4	5	5	2	2	3.3	2
Y5	5	5	2	2	3.1	2
Y6	5	5	2	2	2.7	2
Y7	5	5	2	2	2.9	1
Y8	5	5	2	2	2.4	1
Y9	5	5	2	2	2.5	2
Solo Yam	5	5	2	2	2.7	2

The items and methods are based on discrimination for Yams of National Research Institute of Vegetables, Ministry of Agriculture, Forestry and Fisheries.

Table 1-2. Morphological characters in 9 samples of cultivated yams collected from Yaku Island (Continued from Table1-1).

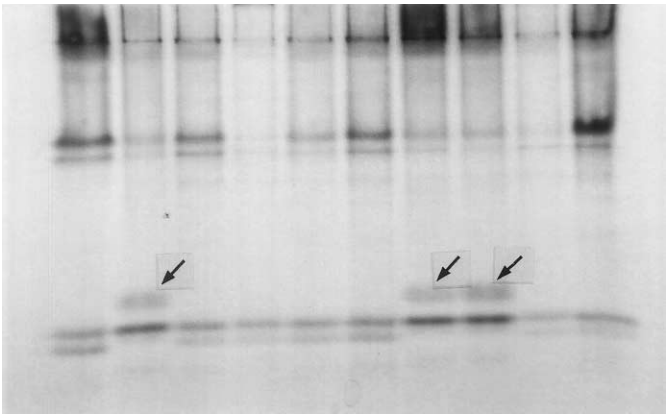
Sample No.	Leaf						
	Length (cm)	Width (cm)	Depth of shoulder (cm)	Width of shoolder (cm)	Length of petiole (cm)	Index of leaf shape	Ratio of length of petiole and leaf length
Y1	14.5	7.9	3.5	2.5	5.4	1.83	0.37
Y2	12.5	6.0	2.6	4.8	6.2	2.09	0.50
Y3	15.1	7.9	3.7	2.7	5.7	1.91	0.38
Y4	15.0	8.5	3.7	3.2	5.7	1.77	0.38
Y5	16.7	8.9	4.0	3.9	5.7	1.88	0.34
Y6	15.7	9.0	3.6	3.8	6.5	1.74	0.41
Y7	15.3	6.8	3.2	4.7	5.5	2.23	0.36
Y8	12.5	6.7	3.2	5.1	5.0	1.87	0.40
Y9	15.0	7.5	3.5	1.9	5.2	1.99	0.35
Solo Yam	14.2	7.1	3.3	3.2	4.5	2.34	0.32

Table 2. Physiological characters of tested tubers.

Sample No.	Fresh color	Changes of color	Viscosity
Y 1	Cream	Non	Strong
Y 2	White	Red brown	Strong
Y 3	White	Non	Strong
Y 4	Cream	Brown	Middle
Y 5	White	Non	Strong
Y 6	White	Non	Middle
Y 7	White	Red brown	Middle
Y 8	White	Red brown	Middle
Y 9	Cream	Non	Middle
Solo yam	White	Non	Strong

Table 3. Morphological characters, water contents and yield of acetone powder of tested tubers.

Sample No.	Tuber			Water content (%)	Yield of acetone powder(%)
	Length (cm)	Width (Max.) (cm)	Length /Width		
Y 1	10.0	8.9	1.1	82.6	18.4
Y 2	13.3	4.1	3.3	77.0	25.5
Y 3	14.4	7.9	1.8	83.3	19.6
Y 4	8.9	6.8	1.3	81.5	18.6
Y 5	13.3	8.4	1.6	82.9	19.1
Y 6	8.8	7.7	2.2	82.0	17.8
Y 7	19.0	8.5	2.2	76.8	22.4
Y 8	16.3	6.9	2.4	80.6	21.7
Y 9	12.7	7.2	1.8	85.3	16.2
Solo Yam	11.3	7.1	1.6	77.7	25.2



Y1 Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9 Solo Yam

Fig.1. Band pattern of tuber protein using polyacrylamide gel electrophoresis.

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