ISSN 1341-9730

Sweetpotato Research Front

NARO Kyushu Okinawa Agricultural Research Center (NARO/KARC) No.30, November 2014

Contents

Technologies Will Change the Future

Masahiro Okamoto

Director General, NARO Kyushu Okinawa Agricultural Research Center

In the field of crop breeding, we frequently hear that we should breed crops focusing on society 10 years in the future because it takes about 10 years to create a new cultivar after starting crossing. However, who can precisely predict the future after 10 years?

I believe that focusing on the future in the field of technical development should not involve forecasting a world far different from today's but perceiving the state of the current society from a brand-new viewpoint and noticing what is lacking in the contemporary society.

A good example is the purple sweetpotato. The NARO Kyushu Okinawa Agricultural Research Center released the first improved cultivar of sweetpotato with purple flesh, "Ayamurasaki", in 1995. No one except a food ingredient company paid attention to it at that time and people were thinking "Who on earth uses sweetpotato with purple flesh?" However, new demands for sweetpotato with purple flesh occurred one after another later, i.e., as a natural purple pigment that is resistant to heat and light, as a health beverage developed on the studies about the function of anthocyanin, and as sweetpotato shochu, a Japanese liquor with a rich fragrance.

Certainly, it seems to be very difficult to change the future. However, we notice that sweetpotato with purple flesh is actually being spread more widely and surely changed the present time, which is the future after 10 years when viewed 10 years ago.

Judging from such facts, I feel that we researchers can state with confidence that technologies will change the future.

Research Paper

Protecting the Sweetpotato from the West Indian Sweetpotato Weevil, Euscepes Postfasciatus (Fairmaire) ~ I.Evaluation of Sweetpotato resistance to Weevil ~

Yoshihiro Okada[1], Tetsufumi Sakai[2], Mutsuhiro Yoshida[3] and Katsuya Ichinose[1]

1. Itoman Resident Office, NARO Kyushu Okinawa Agricultural Research Center

2. Upland Farming Research Division, NARO Kyushu Okinawa Agricultural Research Center

3. Agro-Environment Research Division, NARO Kyushu Okinawa Agricultural Research Center

The weevil, *Euscepes postfasciatus,* is one of the most devastating pests of the sweetpotato, similar to *Cylas* weevils. Sweetpotatoes infested by these weevils produce ipomoeamarones, toxic terpenoids that make tubers unpalatable to any animals. Thus, the weevil often reduces the yield 60 to 100%. The current management of the weevil largely depends on chemical insecticides. Sustainable management for these weevils is desired to reduce the risk of them developing resistance. One desirable characteristic is resistance to the weevil. Unfortunately, little or no information is available on this issue. We examined both the preference of *E. postfasciatus* for sweetpotato cultivars and the antibiotic function of the plants.

We selected 33 sweetpotato cultivars for the preference experiment and placed a tuber of each cultivar in a plastic box, where 100 adult weevils (parents) were released. After 5 d, adults on each tuber were counted, and then removed. Each tuber was kept separately in a plastic bag at 25℃, and new adults that emerged in each bag were counted. The numbers of parent adults and new adults eclosed from the tubers were divided by the tuber weight, and standardized in each replicate. The means of the standardized new adults for each cultivar were plotted against those of parents, graphically revealing five groups (Fig. 1 left): Group 1 preferred tubers for both adult food and oviposition, Group 2 highly preferred tubers for both, Group 3 preferred tubers for oviposition but not for food, Group 4 preferred tubers for food but not for oviposition, and Group 5 did not prefer tubers for either. Cluster analyses performed on these numbers also generated five groups, nearly corresponding to those in the plot diagram (Fig. 1 right).

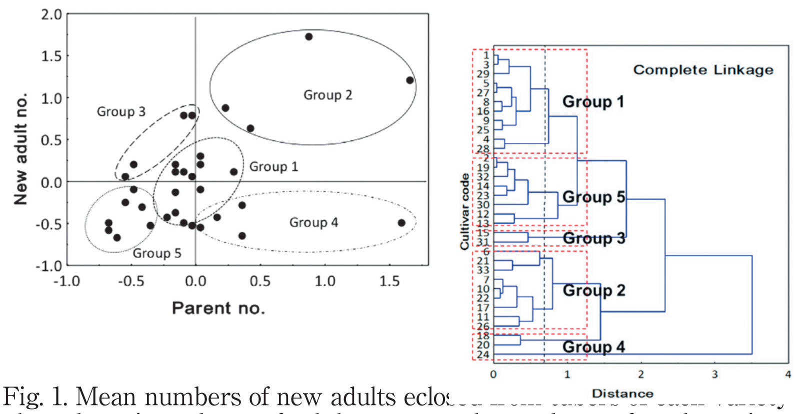

Fig. 1. Mean numbers of new adults eclos... plotted against those of adults attracted to tubers of each variety (left) and dendrogram obtained by cluster analyses (right) which were applied to the ratio of the number of adults attracted to tubers of 33 tested sweetpotato cultivars to the weight of the tuber and that of new adults that emerged from the tubers. For these analyses, the Euclidean distance was calculated to measure the distance between cultivars, and four linkages were examined to combine cultivars. The vertical dashed line in the Complete Linkage panel indicates the distance at which cultivars were grouped.

In the second experiment, one to five cultivars were selected from each group, 16 cultivars in total, and 10 weevil eggs were inoculated on a tuber of each cultivar. The numbers of eclosed adults were similar among cultivars, but eclosion time was shorter and bodies were smaller in Group 1 and Group 2 (Fig. 2). In Group 3, the time was longer and the body was larger. Cultivars of Groups 4 and 5 had emergence periods similar to those of Groups 1 and 2, but similar body sizes to Group 3.

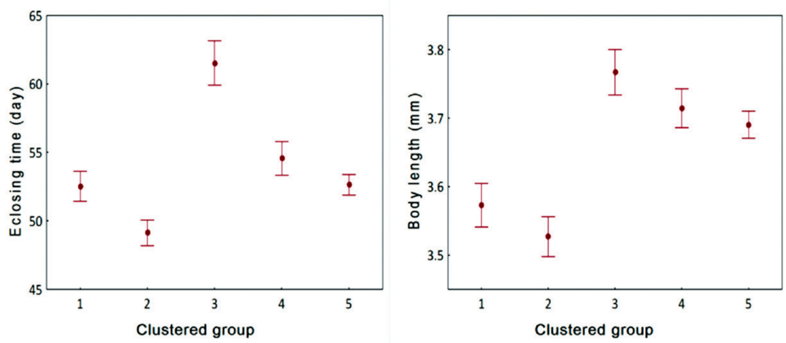

Fig. 2. Means (± sem) of eclosing time of new adults from the inoculation on tubers of 16 sweetpotato cultivars and their body length. Cultivars were grouped in the five clusters revealed by cluster analysis.

The results suggest that, once the weevil breaks the resistance of sweetpotato in food preference and/or oviposition preference (Groups 4 and 5), the growth of its immature weevils can be accelerated and that new adults may be more fertile owing to larger body sizes. Thus, it is highly important to determine how resistance varieties should be planted for IRM (Insect Resistance Management). These studies are now in progress.

Research Paper

Hoshikogane: New Sweetpotato Cultivar for Steamed and Cured Slices, "Hoshi-imo"

Toshikazu Kuranouchi[1], Akiko Takada[1], Yoshiyuki Nakamura[1], Toshiro Fujita[2], Makoto Nakatani[3], Toru Kumagai [1] and Kenji Katayama[1]

1. Field Crop Research Division, NARO Institute of Crop Science
2. Lowland Farming and Horticulture Research Division, NARO Kyushu Okinawa Agriculture Research Center
3. Agriculture, Forestry and Fisheries Research Council, Ministry of Agriculture, Forestry and Fisheries

Steamed and cured slices of sweetpotato called "*hoshi-imo*" are important local agricultural products in Japan. Tamayutaka, a leading cultivar for *hoshi-imo* production, possesses a high storage root yield and moderate quality. However, *shirota* occurs frequently in *hoshi-imo* made from this cultivar. Shirota is a white-opaque defect that deteriorates the taste and the appearance of *hoshi-imo*. It was thus important to breed a new cultivar with low occurrence of shirota.

"Hoshikogane" is a new cultivar bred by the NARO Institute of Crop Science. The cultivar was evaluated at some prefectural agricultural experiment stations as breeding line "Kanto 131." This line exhibited good performance and was registered in 2014 as Hoshikogane.

"Kanto 120" and "Quick Sweet", the parents of Hoshikogane, were crossed in NARO Kyushu Okinawa Agricultural Research Center. Kanto 120 has good storage root appearance and high yield. Quick Sweet has starch with low pasting temperature. The NARO Institute of Crop Science sowed 685 seeds and selected plants from 2004.

Hoshikogane exhibits good sprouting ability and has a semi-compact plant type. The storage root is a short spindle and has no longitudinal groove. Its skin is red-purple. The appearance of the storage roots is moderately good.

The storage root yield of Hoshikogane is about 90% of Tamayutaka (Table 1). The mean weight of a storage root of Hoshikogane is slightly lower than that of Tamayutaka.

Hoshi-imo made from Hoshikogane is light yellow (Photo 1). *Shirota* hardly occurs in this cultivar. The brix of *hoshi-imo* made from this cultivar exceeds that of Tamayutaka. The taste of *hoshi-imo* made from Hoshikogane is almost the same or slightly exceeds that of Tamayutaka.

Hoshikogane is resistant to root-knot nematode and is moderately resistant to stem-rot, but it is susceptible to soil-rot (Table 1). The storability of the storage root of Hoshikogane is lower than that of Tamayutaka, and Hoshikogane is suitable for processing in the early winter.

Hoshikogane is expected to be developed to increase sales by making use of its high yield and quality.

Table 1. Storage root yield and some traits of "Hoshikogane" in field trials.
2007-2011

Traits	Hoshikogane	Tamayutaka
Storage root yield (kg/a)	336	372
Weight of a storage root (g)	274	349
Color of hoshi-imo	Light yellow	Grayish white
Shirota defect	None	Little
Taste of hoshi-imo 1)	Moderately good - Good	Moderately good
Root-knot nematode resistance 2)	R	M
Soil-rot resistance 2)	S	MS
Stem-rot resistance 2)	MR	MR
Storage ability	Low	Moderate

1) Hoshi-imo:steamed and cured root slices.
2) R:resistant, MR:moderately resistant, M:moderate, MS:moderately susceptible, S:susceptible.

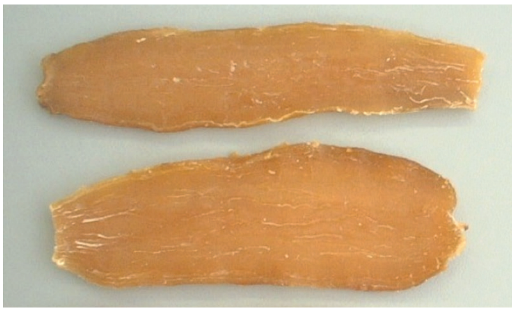

Photo1.*Hoshi-imo* (steamed and cured slices) made from Hoshikogane.

Research Paper

Aikomachi: New Sweetpotato Cultivar for Table Use

Akiko Ohara-Takada[1], Toru Kumagai[1], Toshikazu Kuranouchi[1], Yoshiyuki Nakamura[1], Toshiro Fujita,1[2], Makoto Nakatani[1,3], Seiji Tamiya[1,4] and Kenji Katayama[1]

1. NARO Institute of Crop Science
2. Present address: NARO Kyushu Okinawa Agricultural Research Center
3. Present address: Ministry of Agriculture, Forestry and Fisheries
4. Present address: NARO Hokkaido Agricultural Research Center

One of the leading cultivars of sweetpotato for table use is "Beniazuma" developed in 1984. It accounts for a great portion of the sweetpotato cultivation area of Kanto district. Beniazuma has a slightly good taste and high dry matter content, but it has the following three problems. 1) Sometimes the storage root becomes too large, and this degrades the appearance. 2) The taste of cooked storage root just after harvest is bad because of low sugar content. The sugar content is also varied according to climate conditions. 3) Beniazuma is not suitable for confectionery because of black discoloration after cooking. Therefore, we bred a new sweetpotato cultivar with good appearance, high sugar content, and suitable quality for confectionery.

The new cultivar, "Aikomachi", was developed by NARO Institute of Crop Science in 2012 and registered in 2014. It is a progeny from a cross between "Quick Sweet" and "Kankei 107".

The storage root of Aikomachi has good appearance (Fig. 1). Compared with Beniazuma, the average weight of storage root is slightly light, the yield is comparable, and storability is good (Table 1). It is resistant to root-knot nematode and black rot.

Table 1.Yield and some traits of "Aikomachi" (2006-2012 NICS field)

Traits	Aikomachi	Beniazuma
Storage root yield [1)] (kg/a)	273	269
Average weight of a storage root[1)](g)	194	269
Dry matter content of storage root [1)](%)	37.6	35.6
Root-knot nematode resistance[2)]	R	M
Soil rot resistance[2)]	M	MR
Stem rot resistance[2)]	M	M
Black rot resistance[2)]	R	M
Storability[3)]	M	L

1) Cultivation condition: with mulching film, May planting, October harvesting and 400 plants/a.
Root weight less than 50g was eliminated.
2) There are five classes.
R: resistant, MR: moderately resistant, M: moderate, MS: moderately susceptible, S: susceptible.
3) In a non climate-controlled room throughout winter. L: low, M: moderate.

The steamed storage root of Aikomachi has high Brix, which correlates with sugar content, and the taste is slightly good (Fig. 2). The texture is intermediate to slightly mealy. The flesh is light yellow. Since there is little blackening after cooking and the rate of dry matter content is high, it is suitable for Imoyoukan (solidified sweetpotato paste) and Daigakuimo (sugar-glazed sweetpotato fry), traditional Japanese confectionery (Table 1, Fig. 3).

In Japan, fewer raw sweetpotatos are bought and cooked at home. Instead, more processed foods, including confectionery, are being purchased. Introducing new cultivars and creating original brands has spread in recent years. We hope Aikomachi is chosen and becomes more popular at the place of production. More quality materials will then be supplied for confectionery.

Fig. 1 Storage root of Aikomachi

Fig. 2 Evaluation of steamed root (2006-2012 NICS)

Fig. 3. Aikomachi paste (left), Imoyoukan (middle), and Daigakuimo (right)

Research Paper

IbMYB1 Genotype and Anthocyanin Accumulation in the Storage Roots of Recent Japanese Purple-fleshed Sweetpotato Cultivars

Masaru Tanaka[1], *Masaru Yoshinaga*[1,2] *and Yasuhiro Takahata*[1]

1. Upland Farming Research Division, NARO Kyushu Okinawa Agricultural Research Center

2. Present address: NARO Headquarters

Several recent Japanese sweetpotato cultivars, including Ayamurasaki, accumulate large amounts of anthocyanins in their storage roots and are utilized as an important source of food colorant. Mano *et al.* (2007) suggested that an MYB-domain-containing transcription factor, *IbMYB1*, induces anthocyanin accumulation in the storage roots, but the genetic difference between purple-fleshed and white-fleshed sweetpotato cultivars remained unclear.

To clarify the genetic mechanism of anthocyanin accumulation in the storage roots, we amplified a 1.25 kb-fragment of the *IbMYB1* gene from Ayamurasaki and its spontaneous mutant, AYM96, which lacks both anthocyanin accumulation and *IbMYB1* expression in the storage roots. Sequence analysis of the amplified fragment revealed that AYM96 lacks *IbMYB1-2*, one of the two *IbMYB1* sequences. Amplification of the *IbMYB1-2* fragment cosegregated with purple flesh color of the storage roots in the F_1 progenies derived from the cross between purple-fleshed cultivar Murasakimasari and AYM96 (Fig. 1). These results suggested that *IbMYB1-2* is responsible for anthocyanin accumulation in the storage roots. Further sequence analysis of the *IbMYB1* gene suggested the possibility that genetic rearrangements in the *IbMYB1* region are involved in establishing the *IbMYB1-2* function in storage root pigmentation.

Among Japanese sweetpotato cultivars, *IbMYB1-2* was amplified only from Yamagawamurasaki, an indigenous purple-fleshed cultivar, and its purple-fleshed progenies (Fig. 2). This suggests the importance of *IbMYB1-2* in the breeding of purple-fleshed sweetpotato cultivars in Japan, because recently developed high-anthocyanin cultivars have been selected from the progenies of Yamagawamurasaki. Also, the 309-bp *IbMYB1-2* fragment in Figs. 1 and 2 is useful as a DNA marker, which enables early stage selection of plants containing anthocyanins in their storage roots.

REFERENCES

(1) Mano *et al*., Plant Physiol. 143, 1252-1268 (2007)

(2) Tanaka *et al*., Mol Breed. 29, 565-574 (2012)

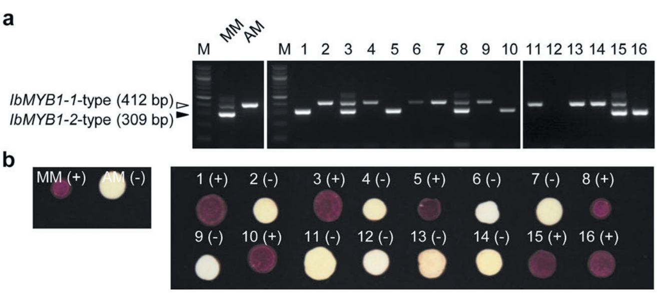

Fig. 1. Amplification of the *IbMYB1-2* fragment (a) and storage root pigmentation (b) in the F_1 progenies between Murasakimasari and AYM96. The presence (+) or absence (-) of the *IbMYB1-2* fragment is shown in the parentheses after a plant name or number in panel b. MM, Murasakimasari; AM, AYM96; No.1-16, F_1 plants, M, 100 bp DNA ladder.

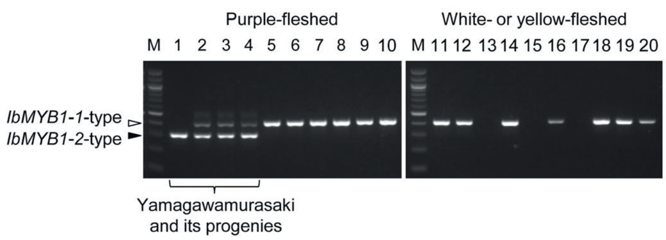

Fig. 2. Amplification of *IbMYB1-2* fragment from various Japanese cultivars.
1, Akemurasaki. 2, Purple Sweet Lord.
3, Kyushu No.109. 4, Yamagawamurasaki.
5, Tanegashimamurasaki (Red skin).
6, Tanegashimamurasaki (White skin).
7, Chiranmurasaki. 8, Fukuyamamurasaki.
9, Bise. 10, Yakushimamurasaki. 11, Tamayutaka.
12, Koganesengan. 13, Beniazuma. 14, Shiroyutaka.
15, Shirosatsuma. 16, Beniotome. 17, Konahomare.
18, Benimasari. 19, Daichinoyume.
20, Kokei No.14. M, 100 bp DNA ladder.

Reader's Talk

Effect of Steamed and Cured Slices of Sweetpotato Intake on Bowel Movement. ~ Regulatory Systems of Health Claims in Japan ~

Naoko Mori

Seitoku University, Department of Human Nutrition, Faculty of Human Nutrition

Mushikiriboshi is sweetpotatoes processed into steamed and cured slices. It first appeared in the 1890s and became consumed everywhere in Japan in the early 20th century. Today, Ibaraki Prefecture is the main producer of Mushikiriboshi, and approximately 80% of it is supplied by small and medium-sized enterprises (farmers) in the Prefecture.

Mushikiriboshi is rich in dietary fiber. According to the Japanese Food Standard Composition list in 2010, Mushikiriboshi contains 5.9 g of dietary fiber per 100 g, while raw, steamed, and baked sweetpotato tuberous roots contain 2.3 g, 3.8 g, and 3.5 g, respectively. Considering the functionality of the dietary fibers, daily dietary fiber intake from Mushikiriboshi might cure defecation problems such as constipation. However, the influence on defecation after intake by humans has not been studied.

We studied the impact of a Mushikiriboshi diet (100 g/day for two weeks) on bowel movement in 84 Japanese female students. In all subjects, the intake of test food significantly increased the stool frequency, stool amount, flatus, and the proportion of subjects who had banana-like soft stools. The effect was remarkable in the constipated group (Fig. 1).

Manifestation of food functionality including agricultural products other than foods for specified health use (FOSHU; also called Tokuho) and foods with a nutrient health claim is banned by the Consumer Affairs Agency in Japan. The acquisition of FOSHU needs the approval of the Japanese authorities after submission of human intervention study data. Therefore, its acquisition might be considerably difficult for small company whose laboratory and business scale are not substantial. The food-labeling system in the U.S. is based on the Evidence-Based Review System for the Scientific Evaluation of Health Claims (2009) and is more flexible than that in Japan. Japanese authorities are currently considering enacting legislation similar to this system. They will probably approve health claims for the fresh foods and processed agricultural foods from April 2015. Industry-academia collaboration is important to ensure the voluntary and rational choice of health foods.

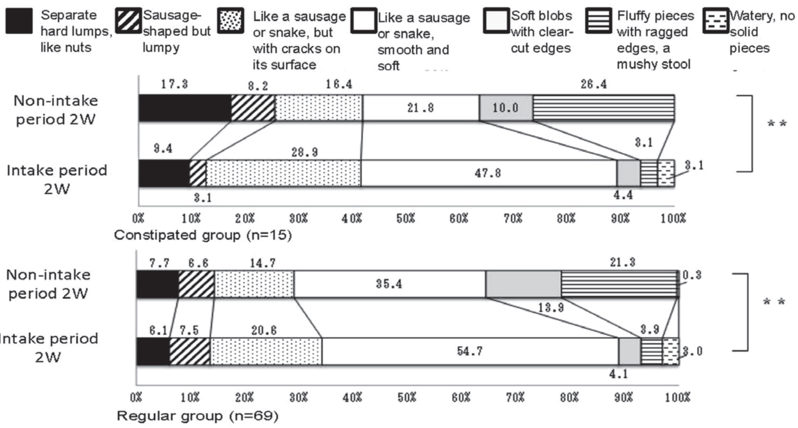

Fig. 1. Change of the form of the stool after consuming steamed and cured slices of sweetpotato.

Constipated group
Defecation less than three days/week.

Regular group
Defecation more than four days/week.

The Bristol stool form scale consists of seven types.
**$p < 0.01$ Chi-square test

Editor's note

NARO International Symposium (the 6th Korea-China-Japan Workshop on Sweetpotato) will be held in Kagoshima Prefecture, Japan, in November, 2014. Sweetpotato is one of the main agricultural products of this prefecture. We hope a lively discussion (S.O).

NARO

Sweetpotato Research Front(SPORF)

Published by the support from the NARO Kyushu Okinawa Agricultural Research Center (NARO/KARC)

Address:2421 Suya, Koshi, Kumamoto 861-1192, JAPAN

E-mail: sporf@ml.affrc.go.jp