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Sweetpotato Research Front

National Agricultural Research Center for Kyushu Okinawa Region (KONARC) No.14, August 2002

Contents

What is the future of global sweetpotato research?

Osamu Yamakawa

Director, KONARC Upland Farming Research Division

I have been in Kyushu since 1969 and a sweetpotato breeder here for 23 years. In the beginning I worked on breeding new cultivars for starch and table use, because these were the types requested by farmers and other users. However, since processing companies recently became interested in sweetpotatoes as raw material, many unique cultivars have been released through KONARC. For example, the high anthocyanin content Ayamurasaki and the high carotene content Sunny Red are used to color food and are welcomed by consumers for their special physiological effects. Moreover, sweetpotatoes may be used for other new purposes such as ornamental plants with colorful leaves and flowers, and as the raw material for such valuable substances as enzymes and medicines.

We were surprised to learn that the Toyota Motor Company is interested in the sweetpotato as a raw material for bioplastic and for automotive biofuel. Currently, corn leads the sweetpotato as a biofuel precursor, but the sweetpotato is preferable to corn, especially in developing countries, because the sweetpotato needs less fertilizer, pesticides and herbicides than does corn. Toyota is already constructing a sweetpotato processing factory in Indonesia, which should be operational by November 2002.

Our institute is a world-class sweetpotato research center, with an international cadre of researchers that can cover almost every field of sweetpotato research. Each year KONARC produces excellent results, and I expect these results to have profitable, global impact when they are published in SPORF.

Research Paper

Endophytic Diazotrophs Inhabiting Sweetpotato Stems

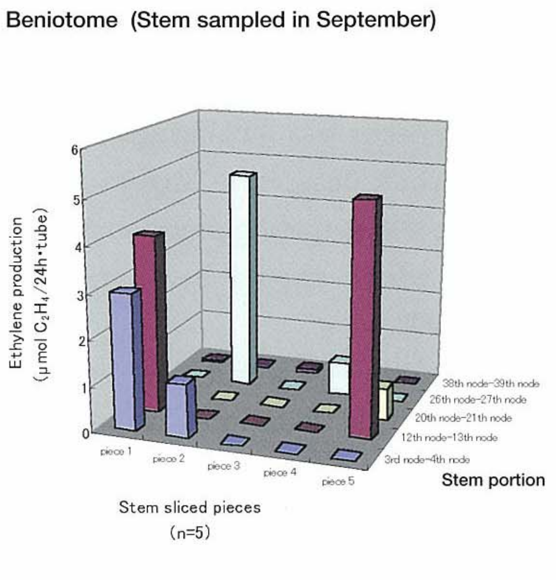
Katsuki Adachi, Hideyuki Mochida, and Yasuhiro Takahata***

Laboratory of Crop Production Management
*Associate Director for Research, Department of Upland Farming Research
**Laboratory of Upland Crop Genetic Resources

We were interested in studying the interaction between endophytic bacteria and the sweetpotato plant *(Ipomea batatas)*, one of the more important crops in the southern Kyushu region of Japan. In this experiment, we used the acetylene reduction activity (ARA) method to confirm the presence of endophytic diazotrophs in sweetpotato plant stems.

Stems of the sweetpotato cultivars Beniotome and Koganesengan were taken from the experimental field, then washed in running tap water for 30 min. Five internode portions from each stem sample were cut out, surface-sterilized, and cut into five thin slices from each internode. Each of the five pieces was incubated in a semi-solid Rennie medium, in test tubes, at 30°C for four or five days under air-phase conditions. After the incubation, the test tubes were closed by W-shaped butyl-rubber stoppers, and approximately 10% of acetylene gas was injected into each test tube headspace. The ability of the bacteria to reduce acetylene to ethylene was determined by injecting 1 mL of the headspace gas into a gas chromatograph 24 hours after incubation. The positive response of the stem cut pieces to ARA shows the presence of endophytic diazotrophs in the original stem portion.

Figure 1 shows the results of the ARA in five cut pieces from different internode portions of cultivars Beniotome and Koganesengan in the tuber-growth stage (in September, four months after transplanting). The results clearly indicated that endophytic diazotrophs were present in the sweetpotato stems. The results also suggested that the existence of the diazotrophs in the stems was not continuous throughout the five thin slices taken from same internode portion, but, in the case of Beniotome, the bacteria were dispersed among the internode portions.



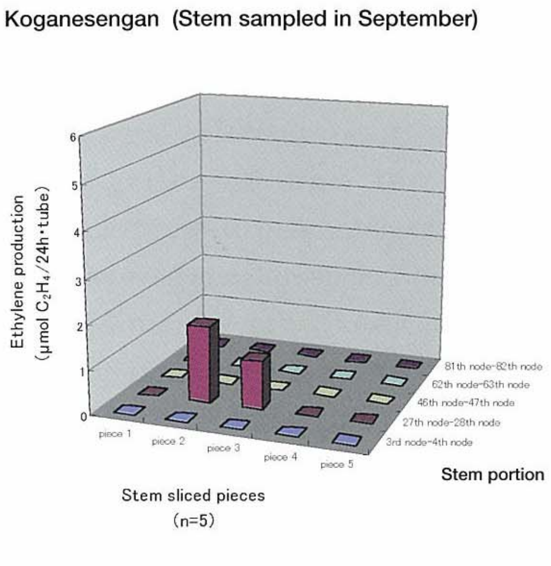


Fig.1. Acetylene reduction activity in five sliced pieces from different internode portions of sweetpotato cultivars Beniotome (left side) and Koganesengan (right side). The node number was counted from the top to the ground side of the stem.

Research Paper

Tamaotome: New Sweetpotato Cultivar for Products Dried after Steaming

Koji Ishiguro, Osamu Yamakawa, Toru Kumagai and Yumi Kai

Laboratory of Sweetpotato Breeding

Introduction

"Tamaotome" is a newly released cultivar with yellow flesh, developed by the National Agricultural Research Center for Kyushu Okinawa Region (formerly the Kyushu National Agricultural Experiment Station). It was evaluated in the prefectural agricultural experiment stations and food processing companies as breeding line "Kyushu No. 118" and officially registered as "Sweetpotato Norin No. 53" by the Ministry of Agriculture, Forestry and Fisheries in 2001 for food processing use, especially for products dried after steaming "Mushikiriboshi".

Origin

Tamaotome is a progeny from a cross between Kyukei 70 and Beniotome conducted at the Ibusuki branch of the station in 1988. Kyukei 70 is a breeding line with good appearance. Beniotome is a cultivar that has a good taste and appearance. Nine hundred seeds were sown in the nursery of the Sweetpotato Breeding Laboratory and selected based on the field performance and processing adaptability.

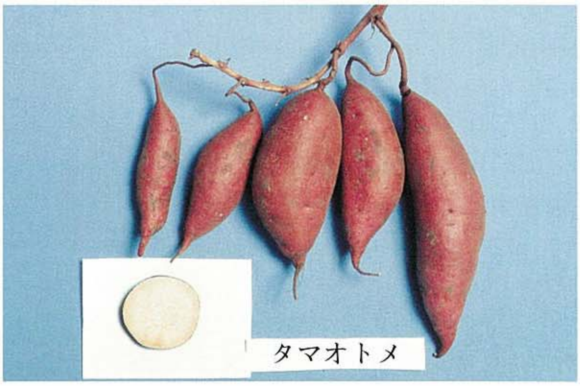
Description

Tamaotome has a moderate sprouting ability and is a prostrate plant type. The top leaves are light green. The mature leaves are green and toothed-heart-shaped. The vines are medium thickness with medium internode length. Vine pigmentation of anthocyanin is very pale, and vine node pigmentation is intermediate. Storage roots are uniformly short fusiform with a good shape, red skin color and yellow flesh color. Texture of the steamed sweetpotato is intermediate with a fair to good taste. Products made from Tamaotome that are dried after steaming exhibit better quality with a clear yellow color and good taste, compared to products from Tamayutaka, a current standard cultivar.

Performance

The yield of Tamaotome is considerably higher than that of Kokei No. 14 and comparable to that of Koganesengan. Dry matter content is slightly higher than that of Kokei No. 14 and less than Koganesengan.

Tamaotome exhibits strong resistance to root knot nematode, intermediate resistance to the root lesion nematode, and slight sensitivity to black rot. Storage ability of the roots is slightly higher than that of Kokei No. 14 throughout winter.



Yield and other traits of Tamaotome in yield trial (1993-2000, Standard harvesting)

Trait	Tamaotome	Kokei No. 14	Koganesengan
Root yield (t/ha)	25.0	20.9	25.9
Root size (g)	237	196	205
No. of roots per hill	2.8	2.8	3.4
Dry matter content (%)	34.2	33.1	36.3
Brix (%)	4.4	4.3	4.5
Root knot nematode resistance[1)]	R	SS	SS
Root lesion nematode resistance[1)]	I	SR	SS
Black rot resistance[1)]	SS	S	S
Storage ability[2)]	SH	M	SL

1) R: Resistant. SR: Slightly Resistant. I: Intermediate. SS: Slightly Susceptible. S: Susceptible.

2) SH: Slightly High. M: Medium. SL: Slightly Low.

Research Paper

Direct Absorption of Acylated Anthocyanin Contained in Purple-Fleshed "Ayamurasaki" Sweetpotato Cultivars by Rats

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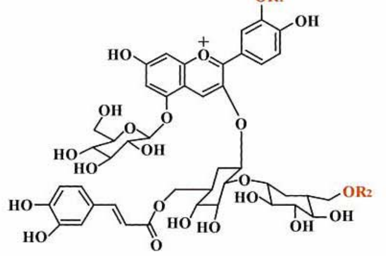
The purple-fleshed sweetpotato contains a high level of anthocyanins. The predominant anthocyanin pigments are mono- or diacylated forms of cyanidin and peonidin (Fig. 1), and they were designated YGM-1 to YGM-6. Although the ratio of acylated anthocyanins (YGM-1 to YGM-6) varies with sweetpotato variety, "Ayamurasaki" and "Murasakimasari (Kyushu-132)" are rich in peonidin aglycon anthocyanins (YGM-4 to YGM-6). In this paper, we describe the absorption of the acylated anthocyanins contained in "Ayamurasaki" by rats.

We prepared a purple-fleshed sweetpotato anthocyanin (PSA) concentrate from "Ayamurasaki" flesh, and administrated it orally to rats by direct stomach intubation . Typical HPLC profiles of anthocyanins detected in rat plasma before and after administration of the PSA concentrate are shown in Fig. 2. YGM-5b was detected as a major peak in the rat plasma HPLC profile. Other anthocyanins were also detected as minor peaks.

Our SPORF members have reported that the "Ayamurasaki" extract possessed *in-vitro* antioxidative (or radical scavenging), antimutagenic, and angiotensin I-converting enzyme inhibiting activities, and exhibited an ameliorative effect against carbon tetrachloride-induced liver injury in rats. In addition, the "Ayamurasaki" extract has demonstrated abilities to restore serum γ-GTP, GOT, and GPT to normal levels in human volunteers with impaired hepatic function and to reduce blood pressure to normal levels in volunteers with hypertension. Here, it is of interest that the acylated anthocyanins were detected in the plasma in an intact form. The evidence leads us to postulate that the absorbed acylated anthocyanins reach the target organs through the circulatory system, and exert their physiological effects as effectively as in *in vitro* assay systems. Actually, after the administration of the PSA concentrate, the rat plasma showed higher radical-scavenging activity than before administration (Fig. 3).



Cyanidin type (R_1=H)	Peonidin type (R_1=CH_3)	R_2
YGM-1a	YGM-4b	caffeic acid
YGM-1b	YGM-5a	*p*-hydroxy benzoic acid
YGM-2	YGM-5b	H
YGM-3	YGM-6	ferulic acid

Fig. 1. Chemical structure of major anthocyanins in the purple-fleshed sweetpotato

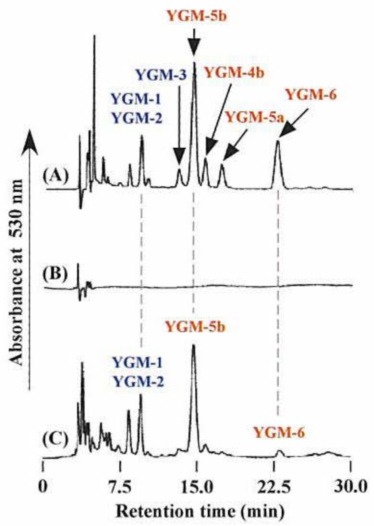


Fig. 2. HPLC chromatograms of PSA concentrate (A) and anthocyanins detected in rat plasma before (B) and 30 min after (C) PSA administration

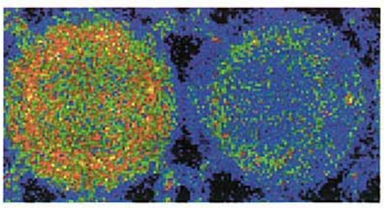


Fig. 3. Image of chemiluminescence produced by reaction between t-BuOO radical and luminol in the presence of rat plasma before (left) and 30 min after (right) PSA administration. A low chemiluminescence (blue) means a high radical-scavenging activity.

Research News

Report on the International Workshop on Anthocyanins

Tooru Kobayashi
Laboratory of Crop Production Management

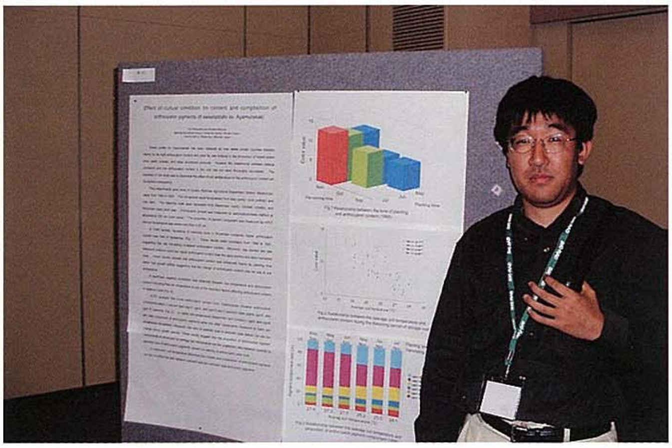
Dr. Takahata, Mr Tanaka and I participated in an international workshop on anthocyanins held in Australia on April 17 to 19, 2002. More than 60 researchers studying anthocyanins participated in the workshop. There were 24 oral presentations and 23 poster papers presented during the workshop. The oral presentations were divided into five sessions:

1) Structure and functions of anthocyanins,
2) Anthocyanin biosynthesis,
3) Regulation of anthocyanin biosynthesis,
4) Plant cell culture and bioprosessing, and
5) Applications for anthocyanins (functionality, health/ dietary aspects of commercial uses).

The titles of our presentations were:

1) Enlargement of variances in amount and composition of anthocyanin pigments in purple-fleshed sweetpotato storage root (Dr. Takahata)
2) Cloning and characterization of the gene encoding dihydroflavonol 4-reductase B (DFR-B) from sweetpotato (Ipomea batatas (L.) Lam.) (Mr. Tanaka)
3) Effect of cultural condition on content and composition of anthocyanin pigments of seetpotato, cv. Ayamurasaki (Mr. Kobayashi).

The workshop covered a wide variety of anthocyanin research topics, and I learned quite a bit of valuable new knowledge about anthocyanins. I thank all the participants and workshop organizers for their kindness.



The Laboratory of Upland Crop Utilization

The new Laboratory of Upland Crop Utilization was established to stimulate the demand for upland crops. In the beginning, the target crop was mainly sweetpotatoes, but recently sugarcane and pineapple were added. The laboratory conducts research on the following subjects:

1) The various kinds of physiological effects; (Antimutagenicity, antibacterial activity, anti-carcinogenesis using human cultured cells, anti-diabetes, anti-hypertension, etc.) of target crops and byproducts.
2) Development of new utilization of byproducts, starch waste, sweetpotato leaves and pineapple waste - such as Shochu (traditional liquor from sweetpotato), processed foods and bio-plastics.
3) The relationship between physiologically functional components and breeding condition of the upland crops.

Our laboratory has been jointly studying these subjects with foreign researchers attending both long- and short-terms studies.

Photo. Staff of Lab. of Upland Crop Utilization.
Back row: Dr. K. Ishiguro, Dr. MS. Islam, Dr. S. Okuno, Dr. M. Yoshimoto
Front row: Mrs. R. Kurata, Miss. Y. Sonoda, Mrs. Y. Kodama

Reader's Talk

Letter to the editor

Ecology of Endophytic Nitrogen-fixing Bacteria Associated with Sweetpotato and Sugarcane Crops in the Southern Kyushu Area

CONSTANCIO AGUIPO ASIS, JR.
JSPS Postdoctoral Fellow, The Philippines

I would like to thank the Japanese Society for the Promotion of Science (JSPS) and the National Agriculture Research Center for Kyushu Okinawa Region (KONARC), especially Dr. Osamu Yamakawa (Director, Department of Upland Farming) and Dr. Katsuki Adachi (Head, Crop Production and Management Laboratory) for giving me the opportunity to continue research on the biological nitrogen fixation (BNF) in nonlegumes.

The BNF process converts atmospheric nitrogen into a form that plants can use. It is an essential process that supports agricultural production by providing the host plant an inexpensive source of nitrogen; the lack of which is the main growth-limiting factor affecting agricultural yields worldwide.

Many reports have confirmed that BNF by endophytic bacteria provides significant amounts of nitrogen to sweetpotato and sugarcane crops. However, the physiology of this interaction has not been fully clarified, and the organs involved in the interaction have not been identified. Hence, my topic in this collaborative research deals with understanding the ecology of nitrogen-fixing bacteria associated with sweetpotato and sugarcane, which are among the more important crops in Southern Kyushu, Japan.

Specifically, we would like to understand how the bacteria get into the plants using different reporter genes, identify the colonization sites inside the plant, and determine the factors affecting the nitrogen fixation of the bacteria in the plant. These information are very helpful in understanding the ecology of this novel plant-microbe interaction.

It is hoped that the output of this endeavor will yield answers to the many questions of the endophytic bacteria-plant interaction mechanisms and pave the way to the ultimate goal of formulating a microbial inoculation strategy to increase crop yields with lower chemical nitrogen fertilizer input.

Announcements

The public exhibition of the National Agricultural Research Center for Kyushu Okinawa Region (KONARC) will be held Nov. 9, 2002 at the Nishigoshi Campus, and Nov. 16, 2002 at the Miyakonojo Campus. You will be able to see the fruits of the sweetpotato study at KONARC as well as many sweetpotato products.

Editor's note

Many products made from the purple-fleshed sweetpotato are always displayed in our research center (SPORF, No.11, p6). The more new products we add to the show corner, the happier I am. (I.S.)

Sweetpotato Research Front (SPORF)
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