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Sweetpotato Research Front

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Contents

COE for Sweetpotato Research

Akihiro Gondoh

Director of the Department of Upland Farming, KNAES

COE stands for Center of Excellence. COE is an outstanding research center with highly qualified researchers, up-to-date research information, excellent facilities and good supporting staff. At KNAES, as a member of the Department of Upland Farming, we aim at becoming a COE for sweetpotato research.

Sweetpotato is produced for many purposes. Besides starch production, it is used in the form of baked potatoes, cakes and liquor. Recently, it has been used for the production of powder, juice, beer and wine. Due to the growing awareness of the need for healthy and natural food, sweetpotato is being appreciated for its nutritic value. Although starch is the main ingredient, sweetpotato also contains many kinds of vitamins, minerals and dietary fibers such as cellulose, pectine, etc.

The department maintains 1,300 accessions of cultivars and 350 accessions of wild relatives. They have been used for the accumulation of useful genes, the development of breeding materials and estimation methods for useful chemical components.

We have released many useful cultivars. We also investigated the cultivation conditions for increasing the processing quality. We developed a planter of sweetpotato cut-sprouts and sweetpotato direct planter. In order to develop zero-emission techniques, we have to analyze all the potential characteristics of sweetpotato.

We plan to hold on International Workshop on Sweetpotato Production Systems at Miyakonojo, Japan, in December this year. It will offer a good opportunity to discuss the strategies for sweetpotato research toward the 21st century.

We hope that we will be able to become a COE for sweetpotato research.

Research Paper

Formation of Storage Roots in Diploid Lines of *Ipomoea trifida*

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Laboratory of Upland Crop Genetic Resources

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Sweetpotato (*Ipomoea batatas* (L.) Lam.) is a hexaploid species belonging to the genus *Ipomoea* in the Convolvulaceae family. Wild species closely related to sweetpotato display polyploidy, and are diploid, triploid, tetraploid and hexaploid. Since sweetpotato is a hexaploid species, it is not easy to introduce valuable genes from wild species with lower ploidy into sweetpotato. To solve these problems and to develop innovative cultivars, the following strategy has been proposed. (1) First, by crossing among diploid species, their valuable characters should be accumulated. (2) Thereafter, the ploidy of the plant can be raised artificially. (3) Resulting hexaploid individuals could be used as superior breeding materials. This breeding strategy has been tested in Japan. Many accessions of related wild species including *I.trifida, I.cordatotriloba, I.triloba, I.lacunosa* and *I.tiliacea* were introduced. However, we have never obtained any superior breeding materials from diploid species, presumably due to the lack of ability of the diploid wild species used in the first step to form storage roots. As a result, we could not improve the performance of the progeny as breeding materials. Thus, the identification of diploid lines that are able to form storage roots is essential for the success in the above mentioned breeding strategy. The increase in root diameter in diploid plants was often recorded, but the shape of the swelled roots was similar to that of pencil-like roots and not to that of storage roots in sweetpotato.

Therefore, we have been screening for diploid lines capable of forming storage roots. We eventually identified a plant that showed root swelling among the progeny of *I. trifida* col. No. 80402 x col. No. 8048. Both parents were diploid, and the top characteristics of the plant were identical with those of the diploid plants. The shape of the swelled roots was similar to that of the storage roots of sweetpotato (Fig. 1). Anatomical observation of the thickest part of the swelled roots (Fig. 2) showed that active primary cambium was formed and the parenchyma cells remained in the xylem. Phloic budles were also detected in the phloem. It is known that this tissue is often observed in certain cultivars. Thus, these anatomical characteristics were similar to those of storage roots of sweetpotato. We are currently propagating this plant to carry out a genetic analysis of the ability to form storage roots.

Fig.1. Swelled roots of diploid line of *I.trifida* (col. No.80402 x col. No. 8048) at 5 months after planting.

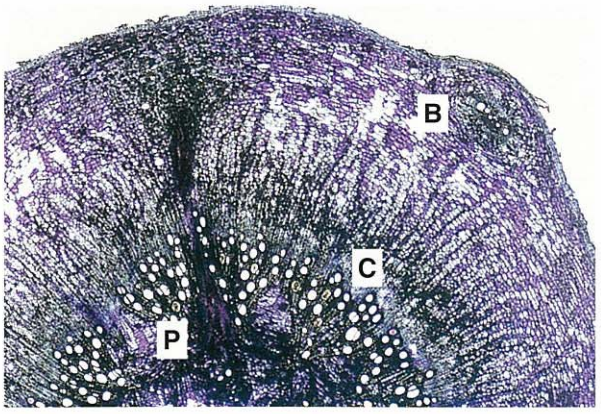


Fig.2. Cross section of the thickest part of a swelled root cut by micro-slicer into sections 40μm in thickness, stained by toluidine blue.
C:Primary cambium, B:Phloic bundle, P:Parenchyma cells remain in the xylem

Research Paper

Simultaneous Determination of Contents of α-Tocopherol and β-Carotene in New Cultivars of Sweetpotato

Shigenori Okuno, Makoto Yoshimoto, Toru Kumagai and Osamu Yamakawa**

Laboratory of Upland Crop Utilization
***Laboratory of Sweetpotato Breeding**

Epidemiological studies indicate that foods containing carotenes and tocopherols may exert a protective role against several kinds of diseases. New cultivars of sweetpotato with orange or purple flesh have been developed as sources of pigments or raw material for juice, and β-carotene contents of several cultivars have been recently reported. Contents of tocopherols of the new cultivars were, however, not determined. A simultaneous determination of the contents of these compounds may be necessary.

Therefore, we performed a simultaneous determination of the contents of both α-tocopherol and β-carotene in sweetpotato cultivars using a high-performance liquid chromatographic (HPLC) system equipped with two types of detectors, UV-visible and spectrofluorometric. The latter was connected to the outlet of the former. Separation of the compounds was performed by use of a reversed-phase ODS column and of MeOH in the mobile phase.

The figure shows the contents of α-tocopherol and β-carotene in several cultivars grown under non-mulching conditions in 1996. Kyukei 174, Kyukei 184, Kyushu 113, Ayamurasaki and Tanegashimamurasaki are purple-fleshed cultivars, while, Kyushu 114, J-Red, Kyushu 122 and Benihayato are orange fleshed ones.

Alpha-tocopherol contents of the purple-fleshed cultivars on a fresh weight basis were higher than those of the orange-fleshed ones, while Koganesengan, a yellow-fleshed cultivar, contained the highest amount of α-tocopherol among the cultivars tested.

A similar trend was observed in the materials grown under cultivation conditions where vinyl mulching and heavy fertilizer dressing were used. All the cultivars tested contained lower levels of β-, δ- and γ-tocopherols than of α-tocopherol. These results indicate that purple-fleshed cultivars do not contain β-carotene but are richer in α-tocopherol than the orange-fleshed ones. The HPLC method for the simultaneous determination of tocopherols and carotenes is particularly useful in saving the time of analysis.

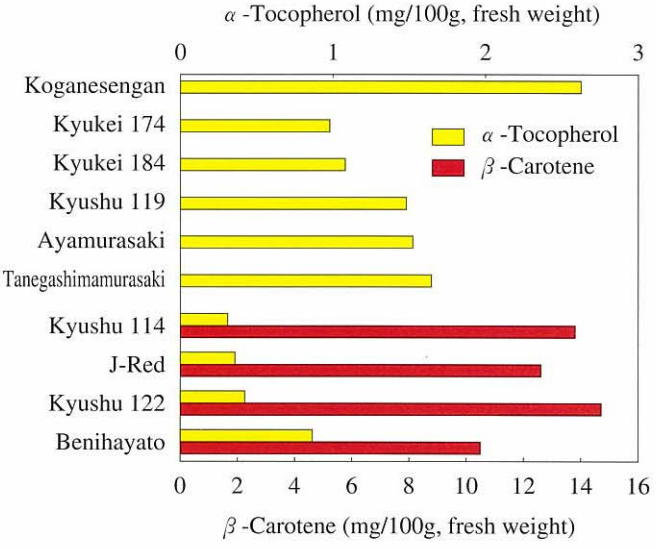


Fig. Contents of α-tocopherol and β-carotene of sweetpotato cultivars.

Research Paper

"J-Red" : New Sweetpotato Cultivar for Juice

Koji Ishiguro, Osamu Yamakawa and Toru Kumagai

Laboratory of Sweetpotato Breeding

"J-Red" is a newly released cultivar with a low starch and high carotenoid content, developed by Kyushu National Agricultural Experiment Station. It was evaluated in the prefectural agricultural experiment stations, food processing companies and universities as breeding line "Kyushu No.120", and officially registered as "Sweetpotato Norin No.49" by the Ministry of Agriculture, Forestry and Fisheries in 1997 for food processing use, especially for sweetpotato juice.

Origin

"J-Red" is a progeny from a cross between "Shiroyutaka" and "86J-6" conducted at the Ibusuki branch of the station in 1988. Collected 312 seeds were sown in the nursery of the Sweetpotato Breeding Laboratory and selected based on the field performance and processing adaptability. "Shiroyutaka" has a high yield and high starch content. It is resistant to black rot and root knot nematode. "86J-6" is a breeding line with a high carotenoid content, originating from an open-pollinated population in U.S.A.

Description

"J-Red" displays a slightly inferior sprouting ability and a prostrate plant type. The top leaves are light green. The mature leaves are also light green and lobed. The vines are slightly slender with medium internode length. There is no anthocyanin accumulation in the veins and nodes. Storage roots are uniformly fusiform with a good shape, orange skin color and orange flesh color. Beta-carotene content of dried roots ranged from 35 mg to 50 mg / 100 g DW depending on the cultural conditions. The sweetpotato juice made from "J-Red" exhibits a better quality with a clear orange color and good taste, compared with carrot juice. As the steamed roots show a low sugar content, "J-Red" is not suitable for table use.

Performance

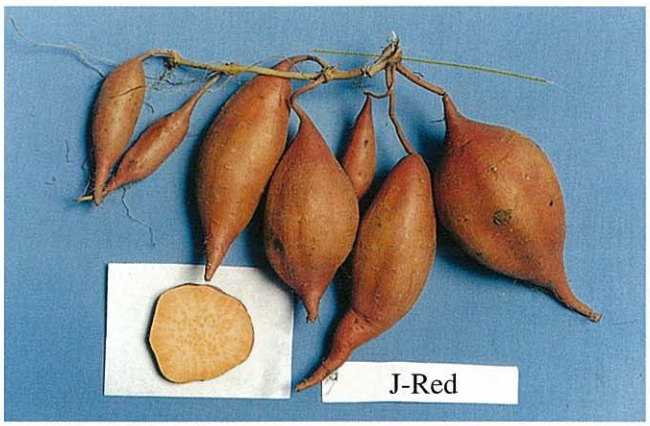
Yielding ability of "J-Red" is considerably higher than that of "Benihayato" and comparable to that of "Koganesengan". Dry matter content is the same as that of "Benihayato", but the starch content is a slightly higher than that of "Benihayato".

"J-Red" exhibits slightly weak resistance to black rot, but a slightly strong resistance to the root lesion nematode, and strong resistance to root knot nematode. Storage ability of the roots is very high throughout the winter.

Yield and other traits of "J-red" in yield trial (1993-1996, standard harvesting)

Traits	J-red	Benihayato	Koganesengan
Root yield (t/ha)	29.7	17.1	25.8
Root size (g)	187	165	193
No. of roots per hill	4.0	2.7	3.5
Dry matter content (%)	25.5	25.1	35.4
Starch content (%)	15.0	13.1	24.3
Brix (%)	3.9	4.2	4.5
Root knot nematode resistance[1)]	R	SR	SS
Root lesion nematode resistance[1)]	SR	I	SS
Black rot resistance[1)]	SS	I	SS
Storage ability[2)]	SH	M	SL
Beta-carotene content (mg/100g DW)[3)]	38.6	41.2	—

1) R:Resistant, SR:Slightly Resistant, I:Intermediate, SS:Slightly Susceptible
2) SH:Slightly High, M:Medium, SL:Slightly Low
3) Data in 1994-1996



Research News

Laboratory of Farm Operation Mechanization Systems (Miyakonojo)

In our laboratory, we are trying to develop a technology for mechanizing planting and direct planting of sweetpotato, to develop drying techniques for roots, stalks and leaves of sweetpotato and to improve the working conditions of a series of operations.

Planting operation of sweet potato is now in the semi-automation stage and requires technical development. In the case of direct planting, cultivation and machine operation, we applid to "J-Red" which is a variety suitable for direct planting.

We developed a technique where by the temperature can be gradually decreased during the drying by heated-air flow of sweetpotato cut into strips. In the powdering process, we are able to preserve the ingredients which contribute to the color of the sweet potato powder.

Harvest operation of sweetpotato is very difficult because of the heavy weight of the roots. We are analyzing carriage operation ergonomically and we are seeking ways of improving it.

Staff of our Laboratory

Laboratory of Soil Resources and Plant Nutrition (Nishigoshi)

Why can sweetpotato grow on infertile soil? How can we improve the productivity of sweetpotato? These are the research themes taken up in our laboratory.

We demonstrated that there was a positive correlation between the content of soluble tuberous protein and tuber yield in two cultivars from various nutrition levels (Fig.). This finding suggests that the accumulation of soluble tuberous protein leads to the increase of tuber yield. About 60 to 80 % of soluble tuberous protein insists of sporamine, a tuberous storage protein of sweetpotato,which is induced by high concentrations of sucrose. We assume that sporamine accumulation in the tuber is controlled by translocated sucrose. Sucrose synthesis competes with starch synthesis in leaf. We currently analyzing the competition between the synthesis of these two products by evaluating the sucrose and starch movement and assaying the synthetase activity under various nutrition conditions.

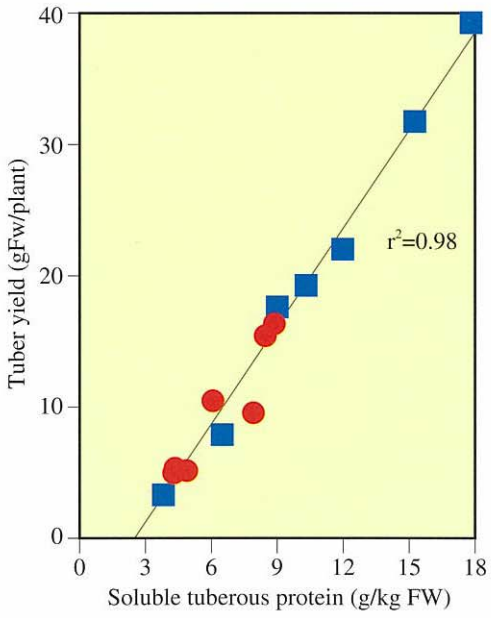


Fig. Relationship between the content of soluble tuberous protein and tuber yield in two cultivars (■;Beniotome ●;Benihayato) when cultivated under different nitrogen and potassium levels (pot experiment).

Reader's Talk

Letter to the editor

United States National Sweetpotato Collaborators Annual Meeting

Don R. La Bonte

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Louisiana State University
Baton Rouge, LA 70803

I would like to extend an invitation to the international sweetpotato research community through SPORF to attend and participate in the United States National Sweetpotato Collaborators Annual Meeting in Little Rock, Arkansas, 31 January and 1 February, 1998. This is a working group composed of scientists from many disciplines, e.g., breeding and genetics, plant pathology, processing, plant physiology, entomology, cultural practices, and plant biotechnology.

Presentations range from the very applied to basic in nature in each of the above areas. This year we are developing a special one-half day session on sweetpotato virology. We particularly welcome scientists with an interest in virology to attend and present their research findings.

If anyone has an interest, please contact me for more information at the above address or at: dlabont@unix1.sncc.lsu.edu

Finally, I wish the Kyushu National Agricultural Experiment Station continued success with their SPORF publication. The international sweetpotato research community is small and scattered throughout the world making communication difficult. Your publication is a very effective vehicle for disseminating current Japanese sweetpotato research to the world.

Announcements

Membership of SPORF is open to sweetpotato researchers of all nations, and SPORF members can receive the SPORF publication free of charge. Also, contributions to "Letter to the editor" are welcome. Everyone can utilize SPORF as a forum to exchange information on sweetpotato research.

Research Meeting for Root Crops will be held on December 4-5 at Miyakonojo city, and International Workshop on Sweetpotato Production Systems toward the 21st Century on December 9-10 at Miyakonojo city. Both Meetings are closed seminars and there is a charge for admission. For further information, please contact: Osamu Yamakawa, SPORF editor.

Editor's note

Typhoon have hit Kyushu island for three times up till the time when I write this editor's note and have done serious damage to the vegetables and crops. I realized fully how important sweetpotato is in the world because it is not affected by typhoon. (M.Y)

Sweetpotato Research Front (SPORF)

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