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Sweetpotato Research Front

NARO Kyushu Okinawa Agricultural Research Center (NARO/KARC) No.26, September 2011

Contents

New Name of Our Institute: "KARC"

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Director General, Kyushu Okinawa Agricultural Research Center (KARC),
National Agriculture and Food Research Organization (NARO)

The National Agriculture and Food Research Organization (NARO), our parent organization, began implementing its third-stage medium-term plan in April 2011. At the same time, we changed the name of our institute from the National Agricultural Research Center for the Kyushu Okinawa Region (KONARC) to the NARO Kyushu Okinawa Agricultural Research Center (NARO/KARC). In accordance with the Basic Plan for Agriculture, Forestry and Fisheries Research formulated under the new Basic Plan for Food, Agriculture and Rural Areas, we will develop technologies related to food security, global warming, and other issues, and will conduct research that creates new demands and enables utilizing local resources.

In executing the plan, NARO reviewed its research system. In the second stage, we instituted a research-team system for facilitating problem-solving research. In the third stage, we will organize research projects into programs and medium-sized projects and assign Program Directors and Project Leaders to strengthen cross-sectional problem-solving activities within NARO. At each of NARO's research institutes, research divisions have been established to smoothly facilitate research projects and develop human resources. Five research divisions were established at NARO/KARC. One of them is the Upland Farming Research Division and is located at Miyakonojo Research Station. This division conducts research and breeding of sweetpotato, as it has always done in the past.

The Kyushu-Okinawa region is home to diverse varieties of agriculture and is an important area for food production in Japan. The food industry has played an important role in the region, so it is important for us to develop the "senary" industry (a term coined by Naraomi Imamura referring to a new industrial category in which the primary, secondary and tertiary industries are integrated) and to foster business collaboration among agriculture, commerce, and industry organizations. NARO/KARC will continue to conduct research designed to deal with these problems appropriately and promptly while closely collaborating with the government under the new research system. We will also promote collaboration with industry, universities, and government agencies. The sweetpotato is an important material for collaboration.

Consumer Expectations for Functional Farm Products

Kazuhisa Goto

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Functional farm products are being produced in response to a health-oriented surge of consumers, so advancement of analysis techniques and breeding techniques has attracted much attention. I therefore attempt to assess the situation of functional farm products that will be demanded by consumers who are strongly conscious of proper diets and health, in the hope of expanding the market. I begin by introducing market research results for functional farm products. The research was conducted in an internet survey involving 1,000 men and women in their 30s to 60s from Tokyo metropolitan areas in Japan.

My research revealed that 50.2% of consumers want to eat functional farm products consisting of fruits and vegetables and 36.6% of consumers wanted to eat their processed foods. This result showed that 94.6% of the consumers want to eat functional farm products. Thus, many consumers want to eat functional farm products of fresh fruits and vegetables. Their reasons for desiring these products were as follows. The nutritive value is high (75.2%), such foods contain many healthy ingredients (55.8%), they looks good for health (44.1%), safety is guaranteed (35.8%), and they are produced in Japan (24.9%) (Table 1).

The functional farm products that consumers want in the future were as follows: high lycopene tomato (65.8%), high β-cryptoxanthin orange (56.0%), vitamin-rich spinach (52.7%), high anthocyanin purple sweetpotato (49.8%), high sesamin sesame seed (47.9%), high quercetin onion (46.5%), high isoflavone soybeans (43.2%), and high carotene sweetpotatoes (42.5%) (Table 2).

Consumer expectations for functional farm products are high and become even higher among health-oriented consumers. There is a strong desire for functional farm products, and many consumers are attracted to the highly nutritious and functional ingredients. These findings are important results for planning and developing functional farm products and expanding markets.

Table 1. Reasons for desiring functional farm products.

Reasons	(%)
Nutritive value is high	75.2
Healthy function ingredient is high	55.8
It looks good for health	44.1
Safety is guaranteed	35.8
It is produced in Japan	24.9
Enough evidence is provided	20.0
The kind that was developed in Japan	19.8
It is produced under natural environment	18.5
It looks delicious	17.8
It is publicized well	1.3
Neighboring people eat	0.6

Table 2. Top ten functional farm products desired by consumers.

Top10	Variety	Cognitive (%)	Intake applicant (%)
1	High lycopene tomato	22.1	65.0
2	High beta-cryptoxanthin orange	11.3	56.0
3	High vitamins spinach	22.3	52.7
4	High anthocyanin purple sweetpotato	30.3	49.8
5	High sesamin sesami seed	9.9	47.9
6	High quercetin onion	9.7	46.5
7	High isoflavone soybean	10.4	43.2
8	High carotene sweetpotato	10.8	42.5
9	High carotenoid potato	18.9	40.2
10	High GABA component rice	6.2	40.1

Research Paper

Konamizuki : New Sweetpotato Cultivar for Starch Production

Kenji Katayama[1], Tetsufumi Sakai[2], Yumi Kai[2] and Masaru Yoshinaga[2]

1. NARO Institute of Crop Science
2. Upland Farming Research Division, NARO Kyushu Okinawa Agricultural Research Center

Introduction

"Konamizuki" is a newly released cultivar for starch production. It was developed at the NARO Kyushu Okinawa Agricultural Reserach Center, formerly the National Agricultural Research Center for Kyushu Okinawa Region, evaluated at prefectural agricultural experimental stations as breeding line "Kyushu No. 159" and submitted for variety registration in 2010.

Origin

"Konamizuki" is the progeny from a cross between "99L04-3" and "Kyukei 236" conducted at the Sweetpotato Breeding Laboratory in 2003. "99L04-3" has a low starch pasting temperature, and "Kyukei 236" has a high starch content and high yield. Two hundred seventy two seeds were sown in the nursery. Selection was based on field performance, starch content and starch pasting temperature.

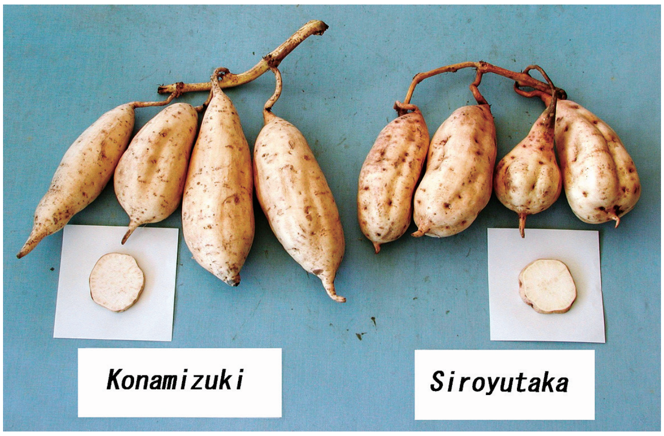
Description

"Konamizuki" exhibits slightly better sprouting ability and is a slightly prostrate plant. The top leaves are light green, the mature leaves are green and cordate. The vine diameter is intermediate with a somewhat short internode length. Pigmentation of anthocyanin is absent in the veins and the vine nodes. The storage root is long and fusiform with white skin and white flesh.

Performance

The yield of "Konamizuki" is comparable to that of "Siroyutaka", a leading Japanese variety for starch production. The dry matter content and starch content of "Konamizuki" are comparable to those of "Siroyutaka". The starch yield of "Konamizuki" is also comparable to that of "Siroyutaka". Starch granules from "Konamizuki" demonstrate an abnormal morphology characterized by cracking into granules. The starch pasting temperature of "Konamizuki" is approximately 20℃ lower than that of "Siroyutaka", as determined by the Rapid Visco Analyser. The peak viscosity of "Konamizuki" is similar to that of "Siroyutaka". The starch retrogradation, evaluated by the percentage of leaked water and hardness of starch gels after cold storage, reveals that "Konamizuki" starch retrogrades much more slowly than "Siroyutaka" starch and exhibits excellent cold storage stability.

"Konamizuki" is somewhat resistant to black rot, somewhat resistant to root-lesion nematode, and resistant to root-knot nematodes. The storage ability of the storage roots is sufficient throughout winter.



Storage root and cross-section of "Konamizuki" and "Siroyutaka"

Yield and other traits of "Konamizuki" in yield trial (2006-2009, standard harvesting)

Trait	Konamizuki	Siroyutaka	Quick Sweet
Root yield (t/ha)	30.5	30.7	20.3
Starch content (%)	24.6	23.6	22.7
Starch yield (t/ha)	7.5	7.2	4.6
Pasting temperature of starch (℃)	58.1	75.5	57.0
Leaked water of starch gel (%)	0.0	19.3	0.0
Hardness of starch gel (N)	0.44	1.64	0.47
Root-knot nematode resistance 1)	R	R	R
Root-lesion nematode resistance 1)	SR	SR	I
Black rot resistance 1)	SR	R	I

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

Research Paper

Carotenoids in Yellow-Fleshed Sweetpotato

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3. Research Institute for Production Development
4. Kagoshima Women's Junior college

Sweetpotato varieties with purple, orange, and yellow flesh have been developed recently in Japan. For example, cv. "Ayamurasaki", "Murasakimasari", "Purple Sweet Load", and "Akemurasaki" with purple flesh; "Sunny-Red," "J-Red", "Hamakomachi", and "Ayakomachi" with orange flesh; and "Tamaotome", "Benimasari", "Beniharuka", and "Himeayaka" with yellow flesh have been released. The main pigments are anthocyanin in the varieties with purple flesh and β-carotene in the varieties with orange flesh. Many commercial products, such as chips, cakes, juices and vinegar, have been developed using purple and orange cultivars. The next breeding objective is to develop a cultivar with deep-yellow flesh. Reports of the carotenoid composition of yellow-fleshed cultivars are scarce, although such cultivars are produced in large amounts in Japan. For this study, we analyzed the total content and composition of carotenoids in yellow-fleshed cultivars and breeding lines, and compared them to those of orange-fleshed cultivars.

The total carotenoid content in eight sweetpotato cultivars or breeding lines with yellow flesh was evaluated by absorption spectrophotometry and compared to that of four cultivars with orange flesh. The content ranged from 1.3 mg/100g dry weight to 3.9mg/100g dry weight in yellow-fleshed cultivars and from 13.5mg/100g dry weight to 39.9mg/100g dry weight in orange-fleshed cultivars. Seventeen carotenoids, including new carotenoids ipomoeaxanthin A, C1 and C2, were detected in yellow- and orange-fleshed sweetpotato by HPLC analysis (Figs. 1 and 2). The main carotenoids were β-carotene 5,8;5',8'-diepoxide (32.4% to 51.4%) and β-cryptoxanthin 5',8'-epoxide (10.8% to 30.0%) in yellow-fleshed cultivars/lines (Fig. 2), while β-carotene (79.5% to 91.7%) was dominant in orange-fleshed cultivars. These results suggest that the content of each carotenoid differs according to flesh color, yellow or orange, although the carotenoid component in the yellow and orange flesh was almost identical. The β-carotene epoxides and β-crypthoxanthin epoxides that abundantly exist in the yellow-fleshed cultivars are the noteworthy components for the breeding selection of a sweetpotato with deep-yellow flesh.

Published Paper

(1) Ishiguro et al., Composition, content and antioxidative acitivity of the carotenoids in yellow-fleshed sweetpotato (*Ipomoea batatas* L.). Breeding Science 60:324-329 (2010).

(2) Maoka et al., Carotenoids with a 5,6-dihydro-5,6-dihydroxy-β-end group, from yellow sweetpotato "Benimasari", *Ipomoea batatas* LAM.,Phytochemistry 68:1740-1745 (2007).

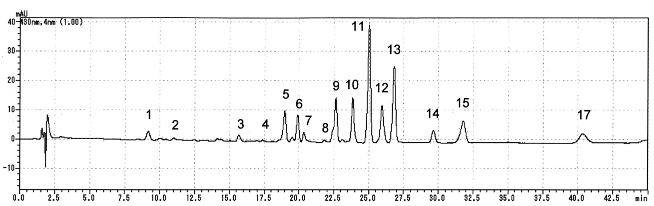

Fig. 1.
HPLC chromatogram of carotenoids from yellow fleshed cv. Tamaotome. Peak identifications 1: unknown, 2: unknown, 3: ipomoeaxanthin A, 4: unknown, 5: unknown, 6: ipomoeaxanthin C1, 7: ipomoeaxanthin C2, 8: β-crypthoxanthin 5,8;5',8'-diepoxide, 9: β-crypthoxanthin 5',8'-epoxide, 10: unknown, 11: β-carotene 5,8;5',8'-diepoxide (*cis*-isomer), 12, 13: β-carotene 5,8;5',8'-diepoxide (diastereomer), 14: unknown, 15: β-carotene 5,8-epoxide, 16: unknown (not detected in yellow-fleshed cultivars), 17: β-carotene.

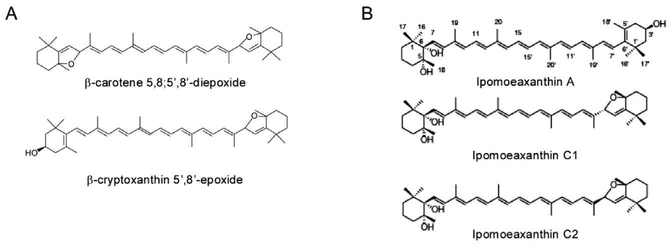

Fig. 2.
Structures of the main carotenoids. (A) β-carotene 5,8;5',8'-diepoxide and β-cryptoxanthin 5',8'-epoxide. (B) new carotenoids, ipomoeaxanthin A, C1 and C2, in yellow-fleshed sweetpotatoes.

Research News

Report of the 4th China-Japan-Korea Workshop on Sweetpotato

Masaru Yoshinaga

Upland Farming Research Division, NARO Kyushu Okinawa Agricultural Research Center

The 4th China-Japan-Korea Workshop on the Sweetpotato was held at Xuzhou JSHP meeting Center in China from 26 to 29 Nov. 2010. It was jointly held with the China-Xuzhou 4th International Sweetpotato Symposium, which was held to celebrate the 100th anniversary of the Xuzhou Academy of Agricultural Sciences (XAAS), organized by the sweetpotato specialty committee of the China Crop Science Society and National Sweetpotato Industrial Technology Research & Development Centre and sponsored by the Jiangsu Xuzhou Sweetpotato Research Centre (Figs. 1, 2). They gathered about 300 participants

Fig. 1. Opening session of China-Xuzhou 4th International Sweetpotato Symposium

Fig. 2. Many symposium participants

including 44 persons from 15 south-east Asian and African countries and Peru where the International Potato Center (CIP) is located. The symposium consisted of five sessions: (1) genetic breeding and germplasm resources, (2) plant physiology and biochemistry, (3) pest-disease prevention and control, (4) nutrition and health care, and (5) food and biofuel processing technology. Thirty-eight research papers were presented orally, and about 70 papers were delivered by posters. The theme of the symposium was "Sweetpotato - securing food and energy." There were several topics on evaluating and improving sweetpotato chemical components such as starch, protein, anthocyanins, and carotene for the stable supply of food and energy. It should be noted that the topic on genetic modification of starch function given by Japanese Dr. Tanaka was popular among the participants. The modified starch was unique and gelatinized at a lower temperature, i.e., 50℃, in contrast to normal sweetpotato starch that gelatinizes at 70° C, and was improved by inhibiting a gene expression coding enzyme of starch synthase II. The starch could be a beneficial material for bio-ethanol production in the future. Apart from the symposium, we had an opportunity to participate in a grand ceremony celebrating the 100th Anniversary of Xuzhou Academy of Agricultural Sciences (XAAS) held in the Xuzhou Royal Resort Garden Hotel. Many posters introducing the achievements of XAAS were displayed in the wide hall, showing the institute's long research history. After the ceremony, we attended the first China (Xuzhou) Modern Agriculture Science and Technology Fair held in the next hall. We could see many agricultural products using recent technology in China and could exchange a variety of information about them (Fig. 3, 4). On the final day, participants visited Sishui Lifeng Food Products Co., Ltd., a joint venture for processing sweetpotato. The big company produced sweetpotato vermicelli and starch in the facilities of refined starch and frozen vermicelli processing (Figs. 5, 6). Finally, we visited the temple of Confucius, the Cemetery of Confucius, and the Kong Family Mansion in Qufu, Shandong Province. We could discover the long history and rich culture in China and in sweetpotato research. The 5th China-Japan-Korea Workshop on Sweetpotato will be held on Korea's Cheju Island in September 2012.

Fig. 3. China (Xuzhou) Modern Agriculture Science and Technology Fair

Fig. 4. Sweetpotato varieties exhibited in the Fair

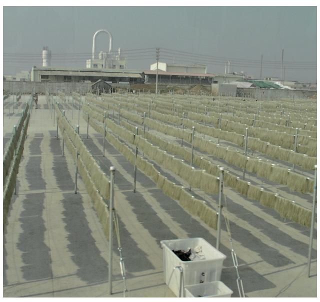

Fig. 5. Sishui Lifeng Food Products Co., Ltd.

Fig. 6. Sweetpotato vermicelli made by starch

Research News

Our Activities in the Next Five Years

Ryoichi Matsunaga

Director of Crop and Agribusiness Research Division,
NARO Kyushu Okinawa Agricultural Research Center

The Crop and Agribusiness Research Division, NARO/KARC has three mandated research fields: genetic improvement, food functionality, and agricultural economy. The Division will contribute to agriculture in the Kyushu Okinawa Region through top-level research and consistent partnership with farmers and the food industry. Field crops of soybean, sugarcane, buckwheat, and Job's tears are being genetically improved in the breeding programs for the Region. Our new varieties, such as spring buckwheat "Harunoibuki", Job's tears "Akishizuku" and high-sucrose sugarcane "Ni27" are being expanded rapidly in the Region.

Research on health functionality of food crops is another mandate in the Division. A database for health-functional compounds of colored sweetpotatoes and soybeans will be constructed to accumulate genetic and environmental variations. The information will be useful for farmers and the food industry who are interested in producing and using value-added food crops.

A consortium of agricultural producers and associates was organized for new agribusiness opportunities with the support of our agricultural economists. This resulted in the successful commercialization of some new products using the black soybean variety "Kurodamaru", which had been developed by our breeders and identified as a highly functional soybean by our food scientists. Thus, our research achievement or newly developed technology can be efficiently disseminated to farmers through the cooperation of the breeders, food scientists, and agricultural economists in the Division.

Job's tears "Akishizuku"

Editoer's note

I've been to the US and was surprised to see how different the sweetpotato cultivars are from Japan. The orange-flesh cultivars are most popular in the US in contrast to yellowish white-flesh in Japan. But, both are sweet and yummy! (H.I.)

NARO

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