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Sweetpotato Research Front

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Report on the 12th Research Meeting for Root Crops Held in Kumamoto Prefecture

Osamu Yamakawa
Chief of Sweetpotato Breeding Lab., KNAES

The 12th Research meeting for root crops was held from December 10 to 12, 1998 at the headquarters of KNAES in Kumamoto Prefecture. About 80 researchers engaged in research on sweetpotato and potato attended the meeting to exchange information on the results and plans for future studies. The discussions on sweetpotato are summarized as follows.

1.Performance trials conducted by the Pref. Agri. Exp.Stn. for newly distributed breeding lines were described. Kyushu-133 showed a good taste and good shape for table use. Kyushu-134 with a high carotene content was selected for table use due to the good taste and good shape.

2.A presentation on the strategy for sweetpotato production in Okinawa was given.

3.Eleven short research topics were presented as follows : 1) Trypsin inhibitor in sweetpotato roots. 2) Properties of regenerated plants from embryogenic callus of sweetpotato. 3) Transgenic system for sweetpotato by using MAT vector. 4) Safety index for sweetpotatoes produced in various areas. 5) Relationship between sensory test and sugar content in sweetpotato roots. 6) Nitrate balance in soil in cropping systems including sweetpotato. 7) Utilization of seedlings generated from small cut tips of sweetpotato roots 8) Varietal difference in tolerance to high temperature depending on β-amylase in sweetpotato. 9) Development of sweetpotato wine using sweetpotatoes with high anthocyanin content sweetpotato. 10) Starch properties of sweetpotatoes under different cultural conditions. 11) Simple and rapid estimation of chemical conponents in sweetpotato tops by NIR.

Picture explanation: Front. Dr. Nagahama, an espert in processing and utilization; Dr. Shiotani, an expert in plant breeding, presents a paper.

Research Paper

Distribution of Anthocyanin Pigments in Storage Roots of Purple-Colored Sweetpotato, Ayamurasaki

*Makoto Yoshimoto, Shigenori Okuno, Tooru Kumagai**
*Masaru Yoshinaga** and Osamu Yamakawa**

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**Laboratory of Upland Crop Genetic Resources

Our recent studies indicated that the anthocyanin pigments purified from purple-colored sweetpotato effectively decreased the reverse mutations induced by various kinds of mutagens[1]. At present, the flour from Ayamurasaki variety has been developed as a material for noodles, bread, a new type of alcohol drink, and a food colorant. In this paper, we describe the distribution of the anthocyanin pigments of the storage roots of Ayamurasaki variety.

The peeled outer layer (about 0.5 cm thick) as the outer portion containing the skin and the cortex was separated from the inner portion without outer layer, respectively. Anthocyanin extract was analyzed using HPLC to determine the ratio of the anthocyanin pigments in both portions.

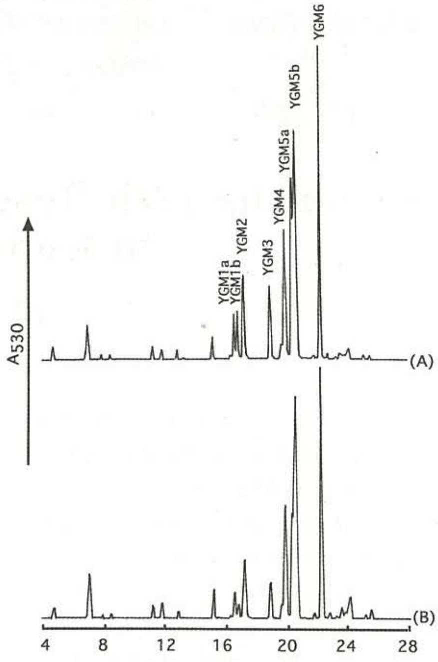
The color value of the extract from the outer portion was 15.8 and that from the inner portion 10.9. The difference in both color values was reflected in the HPLC pattern in that the peaks of the extract from the outer portion were generally higher than those of the inner one (Fig. 1). The main anthocyanin pigments were respectively designated as YGM1 to YGM6.

Ratios of each pigment in the extracts from both portions indicated in Fig. 1 are summarized in Table 1. Namely, anthocyanin pigments corresponding to YGM1a, YGM1b, YGM2, YGM3, and YGM5a were more abundant in the outer portion. Anthocyanin pigments corresponding to YGM1 to YGM3 consist of cyanidin and those to YGM4 to YGM6 of peonidin. Total percentage of YGM1 to YGM3 in the outer portion was 18.6%, while 12.2% in the inner portion. Furthermore, the total percentage of YGM4 to YGM6 in the outer portion was 66.9%, while 65.7% in the inner portion. The cyanidin content in the outer portion was 1.5 times higher than that in the inner portion. These values were in agreement with the increase of the color value in the outer portion, suggesting that cyanidin was abundant in the outer portion.

In conclusion, the outer portion of Ayamurasaki contained a large amount of cyanidin reflecting the strong antimutagenicity of the outer portion. These results suggest that this new variety of sweetpotato with higher physiological functions should be selected. Furthermore our data showed that the functional components were more abundant in the outer portion of sweetpotatoes. These observations indicate that the utilization of the whole root including the skin is important for maximizing the beneficial physiological functions of sweetpotato.

Reference

1) Yoshimoto, M. *et al.* (1999) Antimutagenicity of sweetpotato (*Ipomoea batatas*) roots. *Biosci. Biotechnol. Biochem.*, 63, 537-541.



Retention time (min)

Fig.1.HPLC pattern of anthocyanin pigments in extracts from Ayamurasaki outer or inner portion. (A), outer portion; (B), inner portion

Table 1. Color value and ratio of anthocyanin pigments in extracts from "Ayamurasaki" outer or inner portion

Portion	Color value	YGM composition ratio (percentage of area in Hplc)										
		<YGM1	YGM1		YGM2	YGM3	YGM4	YGM5		YGM6	YGM6>	Total
			YGM1a	YGM1b				YGM5a	YGM5b			
Outer	15.8	9.4	6.1		6.8	5.7	11.1	37.9		17.9	4.0	99.0
			3.0	3.1				15.0	23.0			
Inner	10.9	12.7	3.1		5.7	3.4	11.0	37.0		17.7	7.1	97.7
			2.1	1.0				—*	—*			

*The percentage was not calculated when the separation of both peaks was not distinct.

Research Paper

Tuber Development and Protein Content in Sweetpotatoes

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Laboratory of Soil Resources and Plant Nutrition

Sweetpotatoes grow well under low nutritional conditions because they can use nutrients efficiently in their body. We investigated the relation between tuber development and accumulation of metabolites in the tuber. Two cultivars, "Beniotome" and "Benihayato", were cultivated under L(low) (1mM), M(medium) (10mM) and H(high) (20mM) nitrogen levels combined with L (0.5mM), M(5mM) and H(10mM) potassium levels in a pot experiment. Although the concentration of carbohydrates did not seem to be affected by the nutritional conditions, the concentration of tuber protein was markedly affected with the nutritional condition.

In the early stage of tuberous root development, tuber yields varied depending on the nutritional conditions (Table 1). The concentration of tuber protein increased along with the increment of tuber yield. Both tuber yield and concentration of tuber protein decreased at a high concentration of nitrogen and low concentration of potassium. However, in the middle stage of tuberous root development, plants grown at a high concentration of nitrogen showed the highest concentration of tuber protein although they did not always give the highest tuber yield.

Harvest index (HI) is one of the important factors for tuber production. Varieties with large HI values also produced a high rate of nitrogen in the form of protein (Fig. 1). In other words, they assimilated more nitrogen to proteins. The rate of nitrogen in the form of protein also varied with the stage of tuber growth and nitrogen nutrition. It increased along during the course of tuber growth until the middle stage of tuber root development.

The factors which control tuber growth after the early stage of tuber development and the relation between the cause and effect of nutrition uptake and accumulation of tuber protein remain to be elucidated.

Table 1. Tuber yield and concentration of tuber protein under various nitrogen-potassium nutrient conditions in the early stage of tuber root development

Nuttrient N-k	Tuber yield (*g fresh weightlpot*)		Protein concentration (*g/kg fresh weight*)	
	Beniotome	Benihayato	Beniotome	Benihayato
L-L	3.43	5.36	3.81	4.9
L-M	7.93	5.44	6.49	4.34
M-L	17.56	9.61	9.02	7.88
M-M	19.21	15.47	10.25	8.46
M-H	21.75	16.71	12.01	8.87
H-M	31.61	5.03	15.22	4.26
H-H	38.9	10.48	17.82	6.08

N(mM): L,1;M,10;H,20. K(mM):L,0.5;M,5;H10

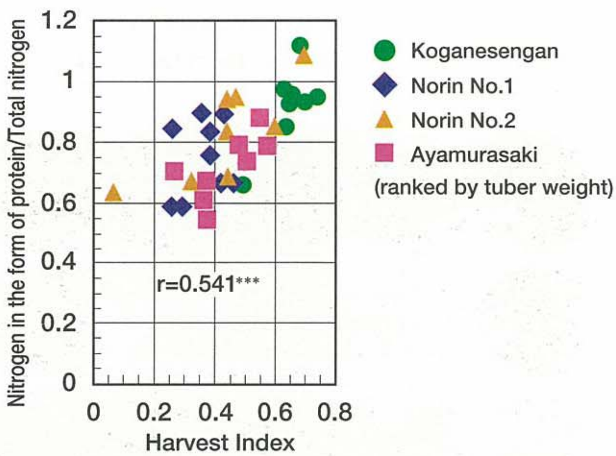

Fig.1. Relation between harvest index and rate of nitrogen in the form of protein in tuber in the middle stage of tuber development. ***, $p < 0.001$
Four cultivars, Koganesengan, Norin No.1, Norin No.2 and Ayamurasaki were cultivated for 110 days with various levels of nitrogen fertilization in a soil pot experiment.

Research Paper

Genotypic Diversity in Paste Color in Purple Flesh Sweetpotato (*Ipomoea batatas* (L.) Lam)

Masaru Yoshinaga, Osamu Yamakawa and Makoto Nakatani*

Laboratory of Upland Crop Genetic Resources
***Laboratory of Sweetpotato Breeding**

Recently, it has been considered that purple flesh sweetpotato may play a role in the preservation of health in human beings due to the detection of radical scavenging and antioxidative properties. Brilliant purple paste may become important for future processed products such as croquettes, potage, jam and confectionery. The major coloring constituents in purple flesh sweetpotato are acylated anthocyanins (i.e. cyanidin and peonidin derivatives). We carried out studies to identify the genetic factors responsible for the variation in paste color ranging from reddish purple to bluish purple (Fig. 1). The paste color was evaluated based on the color reflectance value L* (related to brightness) and b*/a* ratio (index for red blue color). Nineteen sweetpotato clones were classified into two groups based on the b*/a* ratio of the paste: (1) a blue dominant group and (2) a red-dominant group. Analysis of the anthocyanins extracted from steamed roots by spectrophotometry and HPLC revealed considerable differences in the anthocyanin content and composition among the clones. The reflectance value L* of the paste was negatively correlated with the anthocyanin content, while no correlation was found between the b*/a* ratio and the content. Furthermore, a significant positive correlation was observed between the L* value, b*/a* ratio and peonidin/cyanidin ratio. Especially, the blue dominant clones all belonged to the cyanidin type (Fig. 2). These results indicate that in the peonidin types the increase in the peonidin/cyanidin ratio enhanced the degree of redness of the paste, and in the cyanidin type, the blue color predominated. These findings suggest that it is possible to predict the anthocyanin content and composition roughly by the analysis of the paste color without HPLC investigations. The b*/a* ratio of the paste could be used for the selection of the peonidin type, to obtain a paste with a bright and reddish purple color in sweetpotato.

Reference

Yoshinaga, M., O. Yamakawa and M. Nakatani (1999) Genotypic Diversity of Anthocyanin Content and Composhition in Purple-Fleshed Sweetpotato (*Ipomoea batatas* (L.) Lam). *Breeding Science*, 49 (1), 43-48.

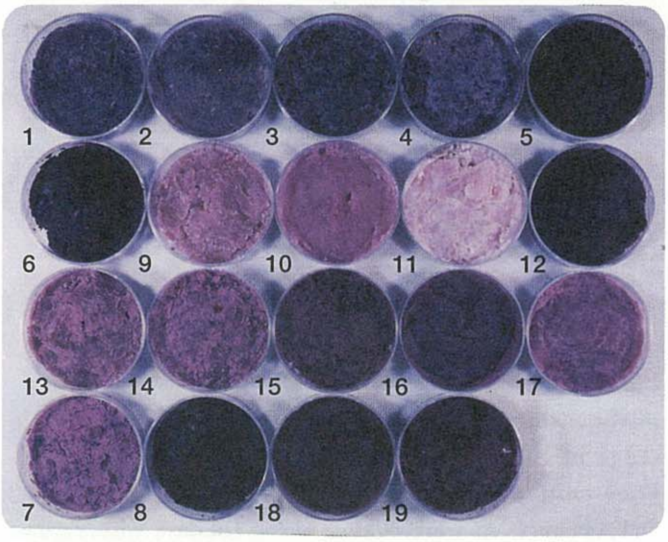

Fig. 1. Variation in the paste color of 19 purple flesh sweetpotato clones. The numbers correspond to the clone No. in Fig. 2.

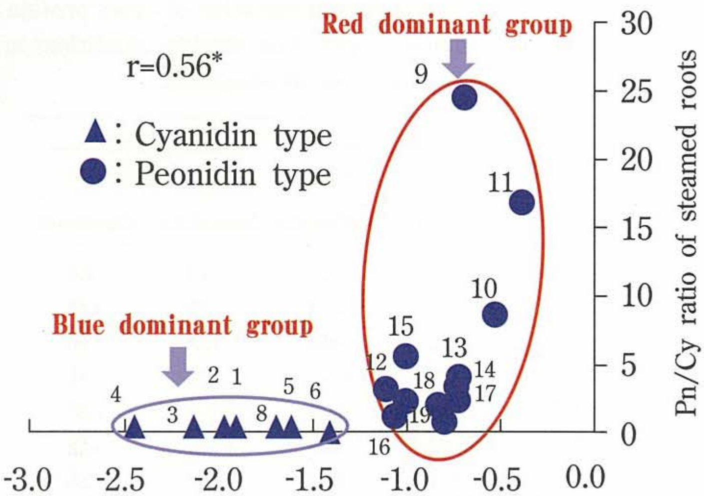

Fig. 2. Scatter plots of Pn/Cy ratio of steamed roots and b*/a* ratio of the paste. * Significant at 5% level. b*/a*, index for red blue color. The numbers correspond to the clone No. in Fig. 1.

Research News

Laboratory of Crop Quality, Storage and Processing (Nishigoshi)

Our laboratory was established to carry our studies on postharvest technology for agricultural products such as soybean, sweetpotato, etc. in Oct. 1991. Research covers quality analysis, quality evaluation including nutritional and physiological functions, quality modification during the storage of crops, and development of new processing technology for the food industry. Staff of our laboratory are working in the Analytical Assessment Center for Producing Crops with High Quality (see SPORF No.2). Recently we here observed human volunteers with impaired hepatic function showed reduced levels of serum gamma-GTP, GOT and GTP after 44 days of continuous ingestion of purple-colored sweetpotato juice made from "Ayamurasaki".

Orange- and Purple-Colored Sweetpotato Juice.

Greenhouse for Crossing Sweetpotatoes (Miyakonojo)

Crossing of sweetpotatoes was performed at Ibusuki Branch of the Sweetpotato Breeding Laboratory, Kagoshima Pref. until June, 1998. The new greenhouse for crossing was constructed near the laboratory at Miyakonojo, Miyazaki Pref. There are three rooms for crossing, and two small nursery rooms for parents and wild relatives. Five staff are involved in the management and crossing activities. Sweetpotato is grafted on wild morning glory to induce flowering. About eighty thousands crossed seeds are collected every year. These seeds are used in the breeding laboratories of both KNAES and National Agriculture Research Center at Tsukuba.

Picture 1 explanation: Staff members engaged in crossing experiments in the greenhouse.

Picture 2 explanation: Sweetpotato parents grafted on wild morning glory inside the greenhouse.

Picture 1

Picture 2

Reader's Talk

Letter to the editor

My two years in Kyushu National Agricultural Experiment Station

Dr. Izabela Konczak-Islam

Laboratory of Upland Crop Genetic Resources, Department of Upland Farming, KNAES

Two years ago I arrived in Miyakonojo from the Crop & Food Research Institute of New Zealand as an awardee of Science and Technology Agency fellowship to conduct research on anthocyanin production *in vitro* in the Laboratory of Upland Crop Genetic Resources of KNAES.

As soon as I arrived in Japan my top priority was to familiarize myself with the conditions and facilities at work place. I was lucky enough to be in an well-oriented group of knowledgeable and professional scientists, group with a multidisciplinary approach to anthocyanin research. With the helpful suggestions of my host researchers Dr. Osamu Yamakawa and Dr. Makoto Nakatani I prepared a feasible research plan to develop an anthocyanin producing cell line and to investigate anthocyanin biosynthesis *in vitro*.

In 1995 the Sweetpotato Breeding Laboratory of KNAES released a new cultivar "Ayamurasaki" with an outstanding quality of accumulating anthocyanin in storage root. From the storage root of this cultivar I have developed a high anthocyanin accumulating cell line. In the dark on modified MS medium the cell line accumulates three times higher anthocyanin than the donor storage root tissue.

While working in the KNAES I was given vast opportunities and high-tech facilities to fulfill my research objectives. Although majority of the instructions for use of equipment was given in Japanese, my colleagues were very supportive in explaining those to me as and when required. I was given opportunity to cooperate with scientists from related areas. I am convinced that such cooperation is much more fruitful than independent and isolated research. As a result my stay in Japan turned out to be the richest experience I have had.

My memories from Japan go far deeper than my work. I found the beauty of Japan and Japanese culture in many places. I enjoyed the spring welcome in the fascinating abundance of white and light pink cherry blossoms at the end of March in the " Mochio Park" in front of our research station. The sun setting in the background of mountain "Kirishima", dominating over Miyakonojo, always attracted my attention. I loved the colorful "Matsuri" during the summer time with songs and dances of hundreds wearing "Kimono" and rich fireworks brightening the dark sky after sunset. I will never forget the visits to beautiful Sendai, science-city of Tsukuba, Tokyo Disneyland, historical Kyoto, "Marine World" on Hakata Island and the exotic cost-line of Miyazaki prefecture.

For the person with a quite different cultural background and with not enough knowledge of Japanese language sometimes it wasn' t easy to cope in the new environment. In such situations I found that Japanese are warm-hearted people, always ready to help and aware that foreigners have language and navigating troubles. I found here real friendship, which I believe will exist beyond the 2-years tenure of my fellowship and beyond the international borders.

Now the time has come for me to move on, enriched and wiser. I would like to thank STA, JISTEC, Dr. Yamakawa and Dr. Nakatani and those who supported me during my work in KNAES for the opportunity to have this great experience in Japan. Thank you Japan for the wonderful time!

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Editor's note

I joined the editorial staff of SPORF after the seventh issue, and it is a great honor for me to edit SPORF which introduces up-to-date reports on sweetpotato activities of KNAES all over the world. SPORF covers various fields of sweetpotato research, including breeding, upland soil, pathology and nematology, biotechnology, quality and utilization, and so on. We do hope that SPORF will contribute to the promotion of your research activities. (K. N.)

Sweetpotato Research Front (SPORF)

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