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Sweetpotato Research Front

National Agricultural Research Center for Kyushu Okinawa Region (KONARC) No.19, February 2005

Contents

Development of Sweetpotato Waste Recycling System in Southern Kyushu

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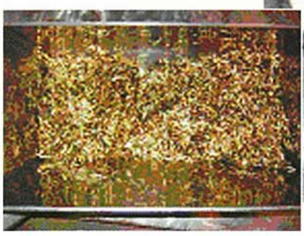
A sweetpotato waste-recycling system is planned for development in the National Agricultural Research Center for Kyushu Okinawa region in southern Kyushu during the years of 2004 to 2006.

This project is part of a study on bio-recycling of wastes from agricultural and fishery sectors implemented by the Biomass Nippon Strategy. The project team consists of prefectural research stations, private companies and universities in Kyushu district. Presently, sweetpotato waste discharged from alcoholic beverage distilleries and starch-producing factories is seldom utilized effectively because of its poor handling properties, spoilage, and bad smell.

Recently, the waste from alcoholic beverages was found to be suitable material for functional vinegar and to include plant growth regulatory substances that suppress weed damage. Starch sediment is found to include β-amylase and several functional vitamins. Furthermore, sweetpotato stems and leaves left after harvesting have been re-evaluated as material of livestock feed and functional food. We are going to develop sweetpotato waste reuse techniques and combine them systematically in ways suitable for southern Kyushu.

Harvesting sweetpotato stem and leaves



Silage with functional substances

Feeding livestock

Research Paper

Purple-Fleshed Sweetpotato Vinegar as a Health Drink

Ikuo Suda and Tomoyuki Oki

Laboratory of Food Functions

There are various types of vinegar, with apple or cider vinegar being the most common table vinegar used in the United States. Wine vinegar is used in the grape-growing regions of Europe. In the Far East, especially in Japan, rice vinegar is the most typical vinegar. Vinegar is one of the keys to good cooking because of its sourness, which is able to bring out the sweetness, saltiness and umami (glutamate-like taste).

Drinking vinegar for its health benefits has become increasingly popular in Japan. One such vinegar is rice vinegar (black) "Kurozu" produced by fermenting a rice-based mixture in an open-air environment. Another is the purple-fleshed sweetpotato vinegar Murasakiimo-su or Beniimo-su. Acetic acid in vinegar is known to be effective in remedying lassitude. Kurozu has been famous for its beneficial effect on whole blood fluidity. Murasakiimo-su and Beniimo-su have been accelerating the purple-fleshed sweetpotato vinegar boom, supported by multiple physiological functions of purple pigment anthocyanin, such as radical-scavenging (antioxidative), antimutagenic, hepato-protective, and antihypertension activities.

Riding the boom, many companies have produced and marketed various purple-fleshed sweetpotato vinegars, using mainly Ayamurasaki, and in some cases Tanegashima-murasaki (a native species) or Murasaki-masari. The purple-fleshed sweetpotato vinegar is drank daily in small quantities, diluting it with water to reduce its acidity. Diluted vinegar is rich in the physiological functional substances, such as acetic acid, anthocyanin, and vitamin C, which give it a refreshing and mellow taste. Unlike colorless vinegar in widespread use for cooking, the purple-fleshed sweetpotato vinegar exhibits a high radical-scavenging activity with a high level of polyphenol.

Fig.1. Purple-fleshed sweetpotato vinegar

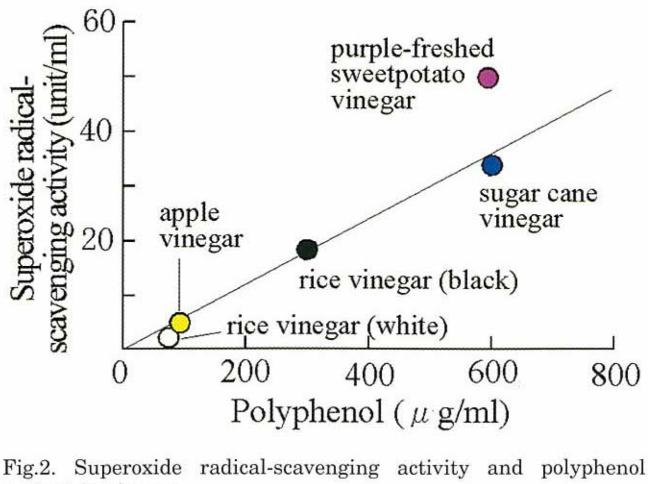


Fig.2. Superoxide radical-scavenging activity and polyphenol content in vinegar

Research Paper

Water- and Oil-holding Capacity and Mutagen Adsorption of Dietary Fiber from Sweetpotato Root

*Makoto Yoshimoto, Osamu Yamakawa and Hayao Tanoue**

Laboratory of Upland Crop Utilization

* Kagoshima Prefectural Institute of Food Processing and Utilization

Introduction

Disposition of the shochu waste, residue from starch industry, and strained residue from the juice production is a critical problem from the viewpoint of environmental protection. Dietary fiber removes health-harmful factors, such as artificial food color, alminium, mutagens, and cholesterol by adsorption of these factors from the body and improves the flora of intestinal bacteria. However, the physiological functions of sweetpotato dietary fibers have been little reported so far.

Materials and Methods

Preparation method of dietary fiber referred to the reports of Noda *et al.*[1] and Takamine *et al.*[2] using α-amylase (Speedase HS, Nagase Biochemical, Co., Kyoto) and glucoamylase (NEO XL-128, Nagase Biochemical, Co., Kyoto).

Water- and oil-holding capacity of the fibers was measured according to the modification of centrifugation method of McConnell *et al.*[3]

For mutagen-adsorption test, fiber sample (20 mg/ml) and Trp-P-1 (25 μg/ml, 3-amino-1,4-dimethyl-5*H*-pyrido-(4,3-*b*) indol, Wako Pure Chemical Industries Ltd., Osaka Japan) were mixed in 5 ml of 10 mM potassium phosphate buffer (pH 7.0) and hold at 37℃ for 1 hr. After the time, the mixture was centrifuged at 1500 x g for 10 min and the supernatant was obtained. The precipitate was mixed with the same volume of the buffer and the remaining Trp-P-1 was re-extracted by the same procedure. The combined supernatants were diluted at 33 times for the mutagenicity assay and the mutagenic activity was evaluated by Ames method using *Salmonella typhimurium* TA 98[4].

Results and Discussion

Correlation of water-holding capacity with oil-holding capacity of sweetpotato fiber (n=18) and commercial sweetpotato fiber (the residue from the ciric acid fermentation of the sweetpotato starch one) is shown in Fig. 1. Flesh color different variety and line, 9 varieties with orange-colored flesh, 5 varieties with purple-colored flesh, and 4 varieties with yellow-colored flesh, were used for this experiment. Water-holding capacity correlated with oil-holding one (r = 0.636). Oil-holding capacity of the fibers from the varieties with purple- and yellow-colored flesh was about 7-16 g/g DW, while oil-holding capacity of the fibers from the varieties orange-colored flesh was about 19-25 g/g DW. Water-holding capacity of the fibers from the varieties with yellow- and orange-colored flesh was about 17-25 g/g DW and about 30-43 g/g DW, respectively. Further water-holding capacity of the fibers from the varieties with purple-colored flesh was about 31-51 g/g DW except for Ayamurasaki (about 10 g/g DW). Water- and oil-holding capacities of the commercial sweetpotato fiber were the same degree as the Ayamurasaki one. Water- and oil-holding capacity of the fibers from the varieties with orange-colored flesh was relatively superior to ones from yellow- or purple-colored flesh. Variety with excellent capacity of water holding was observed in purple-colored flesh ones. The water holding capacity of dietary fiber is thought to be an important determinant of faecal bulking and intestinal transit times with influence gastrointestinal disease.

High capacity of oil holding means to adsorb effectively various kinds of mutagen and cholesterol, because most of these components are lipophilic. Shiroyutaka, Koganesengan, and Kyushu 124 fiber adsorbed 87%−89% of the added mutagen, while the commercial sweetpotato fiber did 56% (Table 1). These results suggest that sweetpotato fiber can effectively adsorb the mutagen.

In conclusion, present data showed that the residue from starch industry of sweetpotato roots was available as the dietary fiber with physiological functions and these capacities depended on the variety.

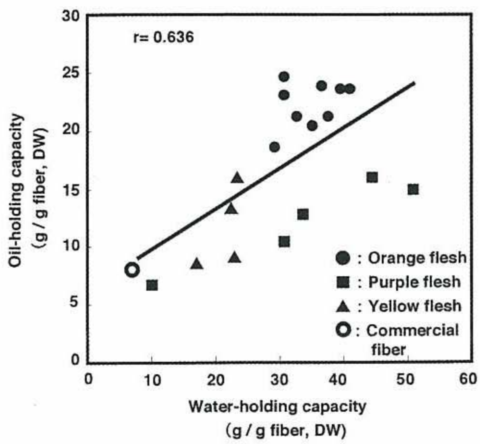


Fig. 1. Relationship between the water- and oil-holding capacities of sweetpotato fiber.

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Table 1 Adsorption of Trp-P-1 to sweetpotato fiber

Sample	Adsorption rate (%) [a]
None	0
Shiroyutaka	87
Koganesengan	89
Kyushu 124	89
Commercial sweetpotato fiber	56

[a] Each value represents the mean ± S.D. of triplicate plates.
The values shown have had the spontaneous mutation frequency subtracted.
Adsorption rate (%) = (1 − y/x) x 100,
y: Number of His^+revertants /plate at no addition of the fiber,
x: Number of His^+revertants /plate at addition of the fiber.

Research Paper

Okikogane: New Sweetpotato Cultivar for Cooking Material and Food Processing

Yumi Kai, Kenji Katayama, Tetsufumi Sakai and Masaru Yoshinaga

Laboratory of Sweetpotato Breeding

Introduction

"Okikogane", developed by the National Agricultural Research Center for Kyushu Okinawa Region, is a newly released cultivar for cooking material and food processing. It was evaluated in prefectural agricultural experiment stations as breeding line "Kyushu No. 147", and was officially registered as "Sweetpotato Norin No. 61" by the Ministry of Agriculture, Forestry and Fisheries in 2004.

Origin

"Okikogane" is a progeny from a cross between "Beniwase" and "Satsumahikari" performed at the Ibusuki branch of the station in 1984. A total of 67 seeds were sown in the Sweetpotato Breeding Laboratory nursery, and selected based on good field performance and low brix of cooked root. "Beniwase" is a cultivar suitable for early planting and harvesting for table use. "Satsumahikari" is a non-sweet cultivar lacking β-amylase activity for food processing.

Description

"Okikogane" has a moderate sprouting ability and is a slightly prostrate plant type. The top leaves are purple brown. The mature leaves are green and slightly three-lobed. The vines are medium thickness with medium internode length. Vine pigmentation of anthocyanin is pale, and vine node pigmentation of anthocyanin is slightly high. Storage roots are uniformly short fusiform, with a slightly good shape, pale yellowish-brown skin color, and pale cream flesh color. The steamed root texture is slightly dry with a slightly bad taste because it is not sweet. "Okikogane" is suitable for a wide variety of dishes, such as a croquette and french-fries.

Performance

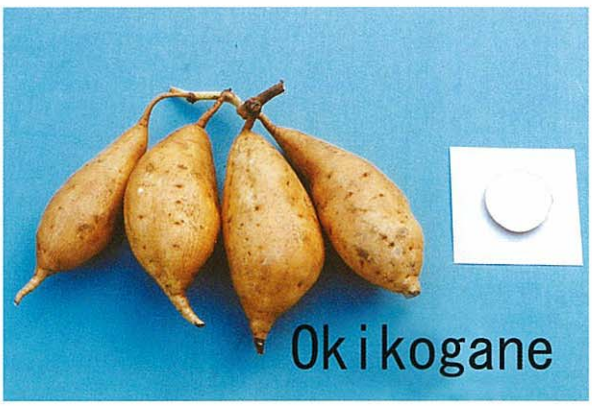
Yield ability of "Okikogane" is higher than that of "Satsumahikari" and "Koganesengan". Dry matter content is less than that of "Satsumahikari" and "Koganesengan". The roots are easily stored throughout winter.

Yield and other traits of "Okikogane" in yield trial (1998-2002, standard harvesting)

Traits	Okikogane	Satsumahikari	Koganesengan
Root yield (t/ha)	31.2	17.1	27.8
Root size (g)	244	191	215
No. of roots per hill	3.3	2.4	3.4
Dry matter content (%)	28.9	32.6	35.1
Brix (%)	2.3	2.3	4.6
Root-knot nematode resistance[1)]	I	R	SS
Root-lesion nematode resistance[1)]	SR	I	SS
Storability[2)]	H	M	SL

[1)] R: Resistant, SR: Slightly Resistant, I: Intermediate, SS: Slightly Susceptible, S: Susceptible

[2)] H: High, M: Moderate, SL: Slightly Low



Research News

The Laboratory of Crop Production Management (Miyakonojo)

In our laboratory, we conduct mainly field experiments using the upland crops of sweetpotato, forage and green manure crops, and vegetables under crop rotation systems. One of the important targeted crops is the sweetpotato. We have several perspectives of utilization of biological functions derived from crop cultivation (nematode-control, weed-control, N_2 fixation, and effective nutrient absorption, etc.) and biomass recycling for crop production in the crop rotation systems. Our research themes are as follows.

1) Establish crop rotation systems to suppress nematode damage by using nematode-resistant sweetpotato cultivars.
2) Control weeds using condensed liquid prepared from sweetpotato spirit waste in upland farming.
3) Develop techniques by utilizing crop-microorganism (endophytic diazotrophic bacteria isolated from sweetpotato stems and arbuscular mycorrhizal fungi) interactions for saving chemical fertilizers.
4) Promote production of high-quality colored sweetpotato cultivars in relation to anthocyanin and β-carotene pigments in sweetpotato storage root.
5) Utilize forage and green manure crops for improving soil physico-chemical properties and weed control.

One of the important research targets of our laboratory is to regulate the use (suppress over-use) of agrochemicals (nematocides and herbicides) and chemical fertilizers for both sustainable crop production and environmental conservation in upland farming in the Kyushu region.

Staff of Lab. of Crop Production Management.
Back row: Mr. T. Suzuki, Dr. K. Adachi, Mr. T. Kobayashi
Front row: Mrs. E. Miyahara, Mrs. Y. Miyauchi

Report of 18th Annual Meeting on Root-Crop Research

Masaru Yoshinaga
Chief of Sweetpotato Breeding Lab.

The 18th annual meeting on Root-Crop Research was held on December 2-3, 2004, at the Kumamoto Prefectural Agricultural Research Center in Kyushu Island. Ninety persons from research institutes, food processing companies, and administrative offices attended.

Regional adaptation trials of sweetpotato lines

Kyushu No. 152 (formerly Kyukei No. 257) was officially approved as a new distributed line for recommended variety determination trials next year. It is a yellow-fleshed line for table use. Kyushu No. 137 and Kyushu No. 148 became candidates for the new variety as requested by prefectural agricultural research institutes. Both are purple-fleshed lines for food processing (Kyushu No. 137) and colorant production (Kyushu No. 148).

Presentation of sweetpotato research topics

Seven topics including post-harvest, biotechnology and cropping system were presented. Two of them related to identification, varietal differences and physiological function of yellow and orange pigments in the storage roots. This research will be informative for the breeding of sweetpotato for food processing such as paste and for improving the demand for the sweetpotato. Participants were interested in using DNA markers as a way of identifying the sweetpotato variety. The Kumamoto Prefectural Agricultural Research Center presented their research on unique cultivation methods, ridge surfaces hardened by mechanical rolling for higher yield and quality of the storage roots compared with black plastic films.

Special lecture

Recent sweetpotato and Irish potato market trends were reported by two lecturers from TOKYO SEIKA Co., Ltd., the biggest vegetable and fruit marketing company in Japan. The lecture gave us important information on what characteristics of the varieties were acceptable in the market or to the consumer. In addition, it taught us the importance of consumer-conscious technology development.

The 19th annual meeting on root-crop research is planned for December 2005 in Miyazaki City.

Reader's Talk

Letter to the editor

Building links between Japanese and Australian innovations

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The Cooperative Research Centre (CRC) scheme brings together universities, public research institutes and companies in 65 centres around Australia. The CRC for Bioproducts has been collaborating with KONARC, with a series of Anthocyanins Workshops organised in Melbourne, Adelaide and Sydney. CRC scientists have taken up invitations to work for extended periods in the KONARC's facilities. We have sent fact-finding delegations to each other's country.

In March 2001, Dr. Masaru Yoshinaga hosted a scientific visit to investigate the food colorants from a cell line derived from the Ayamurusaki sweet potato variety. Just a few months earlier, Dr. Yoshinaga had visited Melbourne with Dr. Osamu Yamakawa and Dr. Makoto Yoshimoto for talks with the CRC and to attend the 1^{st} Anthocyanins Workshop (December 2000). The CRC had cultured the Ayamurusaki line in a 100-L fermenter at its Bioprocessing Scaleup Facility, and this was showcased at the Workshop.

In my March 2001 visit, we were able to look at the anthocyanins profile of the pigments that had been produced under a range of culture conditions and to investigate their stability in applications. The analytical facilities at KONARC enabled the study to demonstrate the potential of the cell culture process as a route of manufacture. The month in *Miyakonojo* was fruitful with unrivalled hospitality by Dr. Yoshinaga, Dr. Yoshimoto, Dr. Yamakawa and the staff at the institute. I was able to see that this was a place producing innovations from a group of highly motivated scientists with many ideas. From our first contacts with KONARC in Melbourne, the CRC had already been made aware of the openness of Japanese scientists, many of whom had lived and trained for long years outside Japan. It was unusually easy to exchange ideas between the CRC and KONARC and many issues could be dealt with openly.

The visit was just as memorable for the time spent exploring the island of Kyushu. I am very grateful to Dr. Yoshimoto for taking the time to make a trip to his family home on the southern tip, sampling the red sweet potato beer as we crossed the countryside. Dr. Yamakawa took everyone to his favourite Korean *kimchi* restaurant in Miyazaki. Dr. Yoshinaga introduced his delightful family and also took time to show me the local cuisine, mountain temples and castles. Dr. Yoshinaga, Dr. Koji Ishiguro, Mr Masaru Tanaka and other colleagues introduced me to the sweet potato shochu in addition to the sake from various prefectures. I am also grateful to Dr. Yoshinori Nakazawa, then the chief of the Sweet Potato Breeding Laboratory. Towards the end of my visit, I was delighted to join in a Spring barbeque organised by Dr. Yamakawa. One cannot but be inspired by the energy and vision of Dr Yamakawa. As one example, his conduct of some research meetings at the institute in English presented a chance to practise but was apparently the first such intrusion into a customary forum.

In April 2002, scientists from round Japan were well represented at the 2^{nd} Anthocyanins Workshop held in Adelaide in the heart of wine-making country. There were delegates from many countries in Europe, Asia and North America and Australasia, and this allowed the CRC and KONARC to profile their research to a broad audience. Towards the end of 2002/early 2003, CRC scientist Dr. Izabela Konczak spent several months working in KONARC laboratories, focusing on the anti-oxidant properties of anthocyanins, successfully comparing cell culture with field-grown plants. In April 2004, the 3^{rd} Anthocyanins Workshop was held in Sydney and again it was well attended and expanded on the themes of the previous Workshops. In between the Workshops, Dr Yoshinaga turned up with colleagues from Tokyo where he was posted at that time at the Forestry and Fisheries Policy Unit.

With the ongoing contact between the CRC and KONARC, both groups are able to consider the potential synergies in terms of research facilities and market opportunities. The communication with KONARC has also allowed the CRC to talk to Japanese companies on food ingredients and other bioproducts. There are many outcomes that may be developed from the Japan-Australia link.

Announcement

The 2006 Korea-China-Japan Workshop on Sweetpotato; Production, Processing and Utilization of Sweetpotato as Functional Food will be held at Kumamoto prefecture, Japan in September 2006. First announcement will be forthcoming later.

Editor's note

Fresh sweetpotatos for table use are now on sale in vegetable stores. Many Japanese welcome this season with a smile. (I. S.)

Sweetpotato Research Front (SPORF)

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