Research Article
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Utilization of unused sea squirt (*Halocynthia roretzi*) Tunics as compost: impacts on the growth and nutritional value of potatoes

Abstract

Sea squirts ("Hoya" in Japanese) are tunicates, marine animals mainly farmed along the Pacific coast of the Tohoku region in Japan. This study aimed to effectively utilize the tunics of sea squirts, an underutilized resource not used for food, by considering their use in compost. This research is part of the recovery efforts following the 2011 Great East Japan Earthquake.

Previously, in study,[1] Japanese radishes were grown using sea squirt tunic compost. The roots and leaves grew large. These radishes were rich in protein and minerals, high in sugar and vitamin C, and contained a significant amount of glutamic acid, a flavor component.

This time, potatoes were grown using sea squirt tunic compost. The potatoes grown with sea squirt tunic compost were smaller in size, but had higher sugar and glutamic acid levels, and twice as much vitamin C as control potatoes. Potatoes grown with sea squirt tunic compost were highly nutritious.

Following our previous report on radishes, we confirmed that sea squirt tunics can be effectively used as compost because they contain many of the nutrients found in potatoes.

Keywords: sea squirts tunics, compost, potato, nutritional value, reconstruction support of Great East Japan Earthquake

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Akiko Yamada Taniguchi,[1] Yozo Mitarai,[2] Machiko Kazami,[1] Haruko Noguchi,[1] Shinichi Oishi[3]

[1]Department of Agricultural Innovation for Sustainability, Faculty of Agriculture, Tokyo University of Agriculture, Japan
[2]Department of School of Design, Sapporo City University, Japan
[3]Food Industry Sixth Sector Producer, Japan

Correspondence: Akiko Yamada Taniguchi, Department of Agricultural Innovation for Sustainability, Faculty of Agriculture, Tokyo University of Agriculture, 1737 Funako, Atsugi, Kanagawa 243-0034, Japan

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Introduction

Sea squirts ("Hoya" in Japanese) are marine animals mainly distributed along the Pacific coast of the Tohoku region in Japan. Sea squirts have a unique flavor characterized by a mixture of sweetness and bitterness, with those harvested in early summer having a stronger sweetness and umami taste. The edible sea squirts are adults, which are orange in color and have a pineapple-like shape. While the larvae drift in the sea like tadpoles, adults are unusual animals that attach to rocks and feed on plankton. Adult sea squirts are covered in a hard tunic called a tunic (Figure 1). The flesh of the sea squirt is edible, but the outer tunic is hard and unsuitable for consumption. The tunics are discarded in large quantities as waste during the processing of the sea squirt flesh Figure 2.

Figure 1 Sea squirt from Miyagi Prefecture, Japan.

Figure 2 Sea squirt **tunics**.

Therefore, this study focused on the underutilized marine resource, the tunic of the sea squirt, and considered the effective utilization of this underutilized marine resource by using sea squirt tunics as compost. In the previous study [1], we used sea squirt tunics as compost to grow Japanese radishes and analyzed their growth and nutritional value to investigate the effects of the compost. The results showed that radishes grown with sea squirt tunics as compost grew 1.2 to 1.3 times larger in both root and leaf size compared to control radishes. Furthermore, the radishes grown with sea squirt tunics were rich in protein and ash, and had high sugar content, vitamin C, and glutamic acid (a flavor component).

Since using sea squirt tunics as compost resulted in larger radishes with higher nutritional content, it was confirmed that sea squirt tunics can be effectively utilized as compost. This time, we investigated the effects of using sea squirt tunics as compost on potato growth and report our findings here. We hope the results of this research will contribute to supporting the fisheries industry in response to the 2011

Great East Japan Earthquake, expanding sea squirt production, and revitalizing the Tohoku region of Japan.

Material and methods

Sample and cultivation method

The sea squirt sample used was "locynthia roretzi" harvested in Miyagi Prefecture, Japan; specifically, the tunics of specimens caught in July 2025 were utilized. Baron potato was used.

Potato cultivation was carried out at the practical training field on the Atsugi Campus of Tokyo University of Agriculture in Atsugi City, Kanagawa Prefecture, Japan.[2] Ten potato plants were planted in rows with a row width of 70 cm, a plant spacing of 40 cm, and a row height of 30 cm (Figure 3). The potatoes were cultivated for approximately 90 days, with sowing in early September and harvesting in early December.

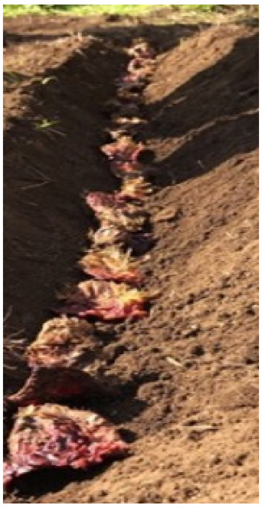

Figure 3 Using sea squirt tunics to create a field.

The potato soil was treated with sea squirt tunics (3 kg/m2). There are two types of potatoes: those grown in sea squirt tunics (hereinafter referred to as "sea squirt tunic potatoes") and those grown in field soil without any treatment (hereinafter referred to as "control potatoes").

Measurement of general food components of sea squirt tunics and potatoes

The general components of sea squirt tunics and potatoes were measured according to analytical methods based on the Standard Tables of Food Composition in Japan, including moisture, protein, fat, ash, and carbohydrates. Moisture was measured by atmospheric pressure heating and drying method.[3] Protein content was measured by Kjeldahl lysis method,[4] fat by Soxhlet extraction method,[5] and ash by direct ashing method.[6] Carbohydrates were calculated by subtraction method.[7]

Measurement of nitrogen and mineral content

Nitrogen content was measured using the Kjeldahl decomposition method [4]. Mineral content was analyzed by atomic absorption spectrophotometric analysis [8]. After ashing, the sample was dissolved in a 0.1 M hydrochloric acid solution. A Shimadzu AA-6300 atomic absorption spectrophotometer was used to measure sodium (589.0 nm), potassium (766.5 nm), calcium (422.7 nm), magnesium (285.2 nm), and iron (248.3 nm). Phosphorus was measured using the molybdenum blue spectrophotometric method [9]

Measurement of nutritional components of potatoes grown in sea squirt tunics

The nutritional components of potatoes grown in sea squirt tunics were measured for sugar content, vitamin C content, glutamic acid content, and pH. Sample preparation involved grinding potatoes in a mixer, centrifuging (10,000 rpm, 10 minutes, 4°C) to obtain an extract.

Sugar content was measured using the Brix meter method,[10] vitamin C content using the hydrazine method[11], and glutamic acid content using the Yamasa Neo[12] L-glutamic acid measurement kit.

Results and discussion

General components and mineral content of sea squirt tunics

As shown in the previous report (Part 1), the general components of sea squirt tunics were 84.6% water, 5.9% protein, 0.3% lipids, 6.3% carbohydrates, and 2.9% ash. After removing the water, it was confirmed that the tunics contained high levels of protein (38%), carbohydrates (41%), and minerals (19%). The mineral content of sea squirts was high, with sodium at 860 mg/100g, magnesium at 120 mg/100g, calcium at 62 mg/100g, potassium at 44 mg/100g, phosphorus at 11 mg/100g, and iron at 2 mg/100g, confirming that they contain sufficient minerals for use as compost.

Sea squirt tunics contain many minerals that support plant growth, such as magnesium, calcium, and iron. Magnesium is a component of chlorophyll necessary for photosynthesis, and calcium is involved in the formation of cell membranes and has the effect of promoting root growth. Phosphorus and iron are minerals involved in photosynthesis, respiration, and physiological activity, and the minerals contained in sea squirt tunics are involved in plant growth.13 In addition, minerals activate microorganisms, improve water retention, soil aeration, and create soil that is resistant to pests and diseases, so sea squirt tunics are considered suitable for compost.

Size of potatoes grown in sea squirt tunic compost

The height of seedlings and leaf size were measured and compared between potatoes grown in sea squirt tunic compost and control potatoes (Table 1, Figure 4). The height of the seedlings was 55 cm for the sea squirt tunic potatoes and 71 cm for the control potatoes. The leaf length was 26 cm for the sea squirt tunic potatoes and 34 cm for the control potatoes. The seedlings and leaves of the sea squirt tunic potatoes were smaller, while the control seedlings and leaves were 1.3 times larger.

Figure 4 Potato seedlings grown using sea squirt shells as compost.

(Left: Potato tubers grown using tunicate compost;

Right: Potato tubers from the control group)

Table 1 The height of seedlings and leaf size of "Sea squirt tunics potato"

	Seedling	leaves
Sea squirt tunics potato	**55 cm**	**26 cm**
Control radish potato	**71 cm**	**34 cm**

Sea squirt tunics potato: Potato grown using sea squirt tunics as compost

Control potato: Potato grown without compost

When the size of the tubers was measured (Table 2), the sea squirt tunic potatoes measured 2.3 cm × 3.0 cm, while the control potatoes measured 2.8 cm × 4.5 cm. The control potatoes were 1.2-1.5 times larger, and the sea squirt tunic potatoes were smaller. The tubers of the potatoes grown in sea squirt tunics weighed 9 g, compared to 18 g for the control potatoes. The potatoes grown in sea squirt tunics were smaller, weighing half as much.

Table 2 The tuber size of "Sea squirt tunics potato"

	Size	Weight
Sea squirt tunics potato	**2.3 cm×3.0 cm**	**9g**
Control potato	**2.8 cm×4.5 cm**	**18 g**

Sea squirt tunics potato: Potato grown using sea squirt tunics as compost

Control potato: Potato grown without compost

Raw tunics are high in protein. If the tunics weren't fully decomposed/aged into stable compost, they might have caused "nitrogen burn" or nutrient immobilization initially. The tunic was applying the periderm in an untreated state, rather than composting it beforehand, may have resulted in stunted seedlings or tubers.

The seedlings and leaves of the potatoes grown in sea squirt tunics were dark green, and we had high hopes for the tuber growth, but the tubers of the potatoes grown in sea squirt tunics were small (Figure 5). We believe that the dark green color of the seedlings and leaves is due to the use of mineral-rich sea squirt tunics compost.

Figure 5 Comparison of potato tuber sizes.

(Left: Potato tubers grown using tunicate compost;

Right: Potato tubers from the control group)

General food components of "sea squirt tunic potatoes (Tubers)" grown in sea squirt tunic compost

The general food components of sea squirt tunic potatoes were examined, and the moisture content was 79.1%, protein content 1.8%, lipid content 0.1%, carbohydrate content 18.1%, and ash content 0.9% (Table 3). Control potatoes grown in soil without sea squirt tunics had a moisture content of 80.3%, protein content 1.5%, lipid content 0.1%, carbohydrate content 17.5%, and ash content 0.6%. It was confirmed that sea squirt tunic potatoes had higher protein, carbohydrate, and ash content compared to control potatoes. As a result, it was found that using sea squirt tunics as compost increases the food components and nutritional value of potatoes, even if the size of the potatoes is small.

Table 3 Component analysis of "Sea squirt tunics potato" (g/100g)

	Moisture	Protein	Fat	Carbohydrates	Ash
Sea squirt tunics potato	**79.1**	**1.8**	**0.1**	**18.1**	**0.9**
Control potato	**80.3**	**1.5**	**0.1**	**17.5**	**0.6**

Nutritional components of "sea squirt potatoes (Tubers)" grown with sea squirt tunic compost

The nutritional components of sea squirt tunic potatoes were 8.1% sugar content, 40 mg/100g vitamin C, and 322 mg/100g glutamic acid (Table 4). Control potatoes had a sugar content of 6.7%, 20 mg/100g vitamin C, and 230 mg/100g glutamic acid. Compared to control potatoes, sea squirt tunic potatoes had 1.2 times more sugar, 2 times more vitamin C, and 1.4 times more glutamic acid. It was confirmed that using sea squirt tunic compost resulted in higher sugar content, higher vitamin C content, and thus higher nutritional value. Furthermore, the high amount of glutamic acid, a flavor component, suggests that other amino acids are also present in large quantities. Potatoes grown in sea squirt tunics were found to be highly nutritious, functional, and potentially contain many other functional components. Determining the content of these other components remains a subject for future research.

Table 4 Nutritional components of "Sea squirt tunics potato"

	Sugar (%)	Vitamin C (mg/100g)	Glutamic acid (mg/100g)	pH
Sea squirt tunics potato	**8.1**	**40**	**322**	**6.0**
Control potato	**6.7**	**20**	**230**	**6.2**

The pH of potato tubers grown using sea squirt tunic compost (pH 6.0) was slightly lower than that of the control potatoes (pH 6.2). This lower pH suggested an increase in acidic components, such as glutamic acid and organic acids, within the potato tubers.

Mineral content of "sea squirt tunic potatoes (tubers)" grown using sea squirt tunic compost

The mineral content of the sea squirt tunic potatoes was as follows: Na: 15 mg/100g, K: 555 mg/100g, Ca: 16 mg/100g, and P: 50 mg/100g; meanwhile, the mineral content of the control potatoes was Na: 5 mg/100g, K: 400 mg/100g, Ca: 4 mg/100g, and P: 40 mg/100g. The sea squirt tunic potatoes contained three times as much Na, 1.4 times as much K, twice as much Ca, and 1.25 times as much P. These results suggest that the potatoes also contain high levels of minerals that were not measured in this study; the content of other minerals will be determined in future analyses. Compared to the control potatoes, the sea squirt tunic potatoes exhibited higher levels of all the measured minerals (Table 5). Based on the results of this experiment, we are thinking the following. Sea squirt tunics are high in sodium (860 mg/100g), and the harvested potatoes had 3x the sodium of the control. High salinity can cause osmotic stress, limit water uptake and tuber expansion while concentrating sugars and nutrients.

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Table 5 Mineral content of "Sea squirt tunics potato " (mg/100g)

	Na	K	Ca	P
Sea squirt tunics potato	15	555	16	50
Control potato	5	400	4	40

It was confirmed that using sea squirt tunics in compost enables the cultivation of functional potatoes with high mineral content.

Conclusion

Following the 2011 Great East Japan Earthquake, sea squirt tunics could not be exported overseas; consequently, despite being safe for consumption, they were discarded rather than eaten. This prompted the initiation of research aimed at resolving the issue of sea squirt tunics waste. The study was motivated by a desire to support the fisheries industry in the wake of the 2011 disaster and to contribute to increased sea squirt tunics production and regional revitalization.

Sea squirt tunics are encased in a tough outer shell known as a tunic. While the inner flesh is edible, the hard outer shell is unsuitable for consumption and is generated in large quantities as waste during the processing of shucked sea squirt tunics meat.

This study aimed to utilize sea squirt tunics shells effectively as compost—an application for an otherwise unused marine resource. Potatoes were cultivated using this sea squirt tunics shell compost, and their growth and nutritional value were analyzed to evaluate the compost's effectiveness.

Analysis of sea squirt tunics shells from Miyagi Prefecture revealed a composition of 84.6% moisture, 5.9% protein, 0.3% lipid, 6.3% carbohydrate, and 2.9% ash; excluding moisture, the shells were found to be rich in protein, carbohydrates, and ash. Mineral analysis showed high levels of sodium and magnesium.

When comparing the seedling height and leaf size of potatoes grown with sea squirt tunics shell compost against a control group, the sea squirt tunics shell-grown potatoes exhibited smaller seedlings and leaves. However, the tubers of the sea squirt tunics shell-grown potatoes were rich in protein and ash, and contained higher levels of sugars, Vitamin C, and glutamic acid—an umami component. Mineral content was also higher than in the control group, with particularly elevated levels of sodium (Na) and calcium (Ca).

It has been confirmed that using sea squirt shells in compost increases the nutritional content of potato tubers, demonstrating the effectiveness of these shells as a composting material.

Although the tubers grown with sea squirt shell compost were smaller in size, this characteristic makes them suitable for processing—a sector where smaller tubers are often preferred. Given their high nutritional value and rich composition, these potatoes represent a valuable agricultural product.

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Conflicts of interest

The author declares that there are no conflicts of interest.

References

1. Akiko YT, Yozo M, Machiko K, et al. Unused resource "Sea Squirt Tunics" used as compost: Impact on the growth and nutritional value of agricultural product "radish". *J Aquac Mar Biol*. 2026;15(1):64–67.
2. Yozo M, Kenta A, Akiko Y T. Influence of Fertilizing Unused Resource 'Sea Squirt Tunics' on Sweet Potato Cultivation - Proposal for Cultivation Learning Program with a Focus on SDGs. *Food, Agriculture Environment. Society of Practical Integrated Agricultural Sciences*. 2024;37;15–20.
3. Akio M, Tatsuyuki S. 2.1.1.2. *Normal pressure heat drying method*. In: New Food Analysis Handbook, Tokyo: Kenpakusha; 1999:15–23.
4. Akiko T. *Quantitative analysis by the Kjeldahl method*. In: Food Chemistry Experiment Textbook for Learning from the Basics, III–2 Overview of Experiments on Proteins and Amino Acids, 10. Tokyo: Kenpakusha; 2014:50–53.
5. Akio M, Tatsuyuki S. *2.3.1.1. Lipids*. In: New Food Analysis Handbook. Tokyo, Kenpakusha. 1999:57–102.
6. Akio M, Tatsuyuki S. *2.5.1 .1. Direct incineration method*. In: New Food Analysis Handbook.Tokyo: Kenpakusha. 1999:152–154.
7. Akiko T. *Calculation by subtraction method*. In: Food Chemistry Experiment Textbook for Learning from the Basics, III–4 Summary of Experiments on Carbohydrates and Sugars, 20. Tokyo: Kenpakusha; 2014:78–79.
8. Akio M, Tatsuyuki S. *2.5.5. Quantitative method of inorganic substances*. In: New Food Analysis Handbook. Tokyo: Kenpakusha; 1999: 164–193.
9. Akiko T. *Determination of phosphorus by molybdenum blue colorimetric method*. In: Food Chemistry Experiment Textbook for Learning from the Basics, III– 30 Quantitative Tokyo, Kenpakusha. 2014:100–101.
10. Akiko T. *Sugar Content*. In: Food Chemistry Experiment Textbook for Learning from the Basics, III–38 Sugar Content, Acidity, and Quality of Fruits, Tokyo, Kenpakusha;2014: 122–123.
11. Akio M, Tatsuyuki S. *2.6.2.9. Vitamin C; hydrazine method*. In: New Food Analysis Handbook. Tokyo: Kenpakusha; 1999: 233–239.
12. Cosmo Bio Co., Ltd. L–Glutamate Measurement Kit "Yamasa Neo".