Producing Hydrogen from Sake Waste

for Sustainable Development in Niigata

Team number:1

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Note. From “Guide to Japanese sake,” by byFood (2021), https://www.byfood.com/blog/culture/guide-to-japanese-sake

Agenda

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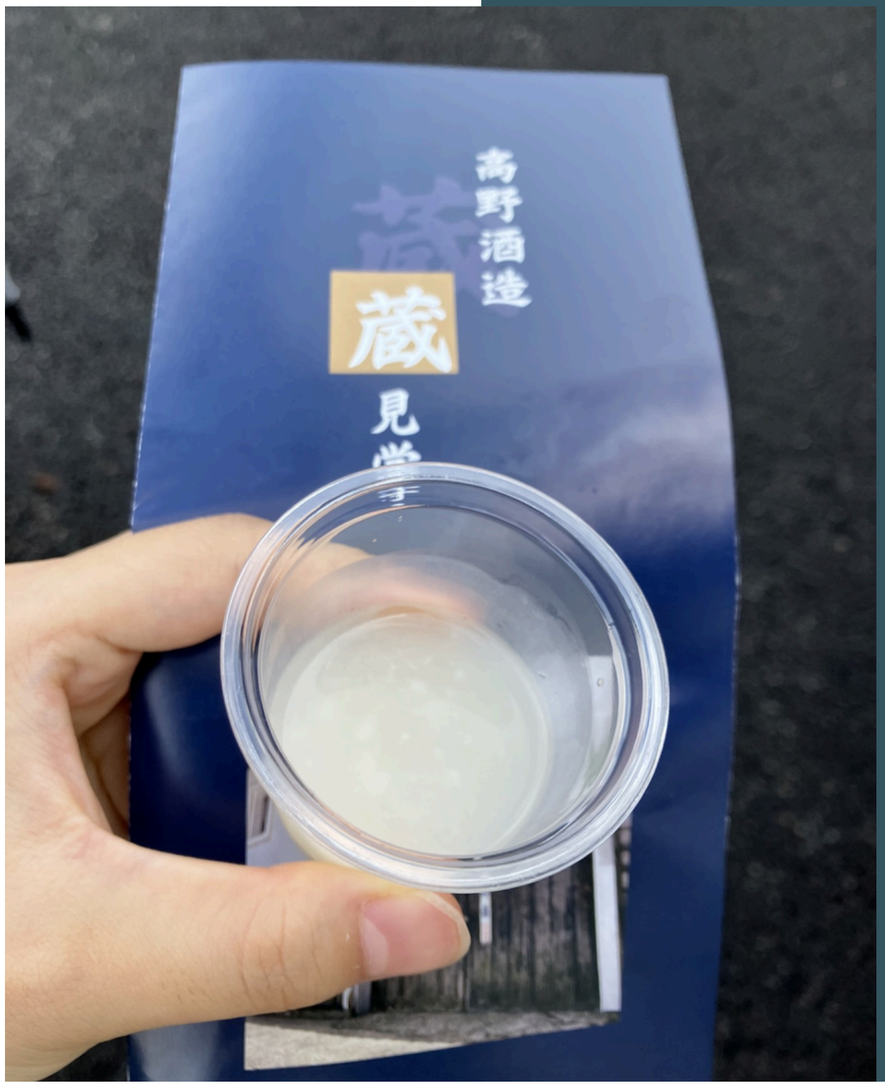
Note. From “Plastic SAKE Brewery,” by F. Goto (2022), designboom. https://www.designboom.com/design/fumiaki-goto-plastic-sake-brewery-07-07-2022

1.Introduction

- Every year, Japan produces around 32,000 tons of sake waste about 10% of total sake output. While some is reused in food, compost, and cosmetics, much remains unused.
- Regions like Hokkaido have shown that agricultural waste can be turned into hydrogen energy. As a major sake producer with 85 breweries, Niigata has both the resources and potential to lead in sustainable energy innovation.



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Source: Sake Street (2021)
Source: Sakura Sake Export (n.d.)
Source: Hydrogen Energy Systems Society of Japan [HESS] (2023)

2.What is Sake Production Waste?

“sake kasu” or “sake lees”

- By-products produced during the sake brewing process.
- After fermentation and pressing, not all of the mash becomes sake — a significant portion is left behind as solid by-product known as sake kasu (酒粕), or sake lees.
- It is highly nutritious and is rich in protein, dietary fiber, and vitaminB.

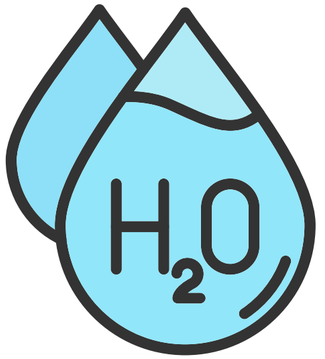
Source:Takara Shuzo Co., Ltd.(2024)
https://chomiryo.takarashuzo.co.jp/knowledge/detail/116/

2.What is Sake Production Waste?

- When making sake, 1ton of rice can produce 3000L of sake, including 20-25% sake lees as a biomass by-product.

- This sector has the potential to produce 27-35 kilotonnes of sake lees each year

- Biohydrogen production improvement using hot compressed water pretreatment



Source:Miftahul Choiron, Seishu Tojo, Tadashi Chosa(2020)”Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste - Consensus”

Note. From “Guide to Japanese sake,” by byFood (2021), https://www.byfood.com/blog/culture/guide-to-japanese-sake

3. What is Hydrogen?

Hydrogen (H_2) is the lightest, colorless, and odorless gas.

- When used as fuel, it produces only water vapor, making it a clean and eco-friendly energy source.
- Hydrogen can be produced from water electrolysis, organic waste, and biomass.
- In Japan, research and projects are actively developing hydrogen from agricultural and food waste.

Source: Britannica (2025)
Source: U.S. DOE (n.d.)

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3. What is Hydrogen?

However…

- Most commercially produced hydrogen comes from fossil fuels

Utilizing renewable resources for hydrogen production

- More environmentally friendly

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Source:Miftahul Choiron, Seishu Tojo, Tadashi Chosa(2020)”Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste - Consensus”

4.Technology to Convert Sake Waste into Hydrogen

1.Collection and Pretreatment of Sake Kasu

Collect sake kasu from breweries and dry it to about 40% moisture content by removing water.

2.Loading into Reactor

Feed the dried sake kasu into biomass gasification or dark fermentation reactors to produce hydrogen.

3.Hydrogen Capture, Purification, and Compression

Separate and purify hydrogen from the produced gas, then compress it for easier storage and transportation.

4.Supply

Deliver the purified and compressed hydrogen to hydrogen stations or the power grid for use as fuel in homes and vehicles.

source:Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste(2020)
https://www.sciencedirect.com/science/article/abs/pii/S0360319920316037?utm_source=chatgpt.com

5.Benefits for Niigata’s Community and Environment

- Local job creation in the bioenergy and circular economy sectors
- Reduction of landfill waste and waste management costs
- Promotion of energy self-sufficiency for rural areas and farmers
- Contribution to Japan’s Hydrogen Roadmap and the Sustainable Development Goals (SDGs)

source:EU-Japan -Japan’s Circularity(2020)
https://cdnw8.eu-japan.eu/sites/default/files/publications/docs/japans_circularity_-_helene_bangert_-_11.12.2020.pdf?utm_source=chatgpt.com

6.Case Study / Examples

How much can be saved in 5 years by using sake lees biomass instead of fossil fuels for the same households?

Category	Fossil Fuels	Hydrogen from biomass
Energy Production	40.5 GWh	Equivalent
CO_2 Emissions	~18,225 metric tons	~18,225 metric tons CO_2 avoided
Energy Value	~$10.125 million	Equivalent (valued at $0.25 per kWh)
Operating Cost	— (assumed market power purchase)	~$5.25 million cost savings
Environmental Value	High carbon footprint	Significant sustainability advantage

6.Case Study / Examples

Producing hydrogen from sake kasu biomass and supplying it to 740 homes over 5 years can:

- Avoid approximately 18,225 metric tons of CO_2 emissions
- Achieve energy cost savings of about $5.25 million (approximately 740 million JPY) over 5 years
- Contribute to regional energy self-sufficiency and promote a circular economy

source:Hydrogen production from biomass: A review combined with bibliometric analysis (2025)
https://www.sciencedirect.com/science/article/abs/pii/S0360319925012728?utm_source=chatgpt.com

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Challenges

1. High Energy Input: The process often requires hot compressed water (HCW) pretreatment at elevated temperatures (130–180°C) and pressures, which consumes significant energy and may offset some environmental benefits of hydrogen production from waste

2. Process Complexity: Achieving optimal hydrogen yields depends on carefully controlled conditions (temperature, pressure, and time), making the process technically demanding and potentially costly to scale up

Source:Miftahul Choiron, Seishu Tojo, Tadashi Chosa(2020)”Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste - Consensus”

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Solution # 1

High Energy Input

Temperature and Time Adjustment

- By optimizing the temperature and duration of hot compressed water (HCW) pretreatment, it is possible to improve the breakdown of sake lees while reducing unnecessary energy consumption.

- For example, 130°C for 60 minutes achieved the highest hydrogen yield, showing that excessive temperature or time can be avoided for better efficiency

Source:Miftahul Choiron, Seishu Tojo, Tadashi Chosa(2020)”Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste - Consensus”

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Solution # 2

Process Complexity

Improvement of Fermentation Process

- Shortening Lag Phase: HCW pretreatment can reduce the lag phase (the delay before hydrogen production starts), making the overall process more efficient

- Utilizing Beneficial Microbes

Maintaining and using hydrogen-producing bacteria such as clostridium species helps ensure stable and effective fermentation

Miftahul Choiron, Seishu Tojo, Tadashi Chosa(2020)"Biohydrogen production improvement using hot compressed water pretreatment on sake brewery waste - Consensus"

8.Conclusion

- Transforming sake lees into clean energy drives local innovation, sustainability, and energy independence.

- Niigata can lead Japan’s future through a 'waste-to-hydrogen' model blending tradition and technology.

9.Reference

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Group1

Thank you for listening!