Studies on Sake Fermentation from Blend of Sticky Millet and Job's Tears

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ABSTRACT

Sticky millet and Job's tears are indigenous cereals with high nutritional valueFermentation of these cereals into alcoholic beverages represents an effective strategy to enhance their added value and biological functionality. This study aimed to investigate the production of sake from sticky millet combined with Job's tears and to evaluate the key biological properties of the resulting products. Sake was produced from sticky millet combined with either dehulled or non-dehulled Job's tears, using 1.02 g of starter culture per 50 g of cooked sticky millet and 100 g of cooked Job's tears. Solid-state fermentation was conducted in a 1.45 L container at room temperature (25–30 °C) for 7 days, followed by the addition of 350 mL of drinking water. Samples were collected during fermentation and analyzed. After 13 days of fermentation, sake produced with non-dehulled Job's tears showed a decrease in reducing sugar content from 30.58 to 11.26 mg/mL, whereas sake produced with dehulled Job's tears exhibited an increase from 44.08 to 51.55 mg/mL. Correspondingly, ethanol content was higher in sake produced with non-dehulled Job's tears (4.31% v/v) compared to that produced with dehulled Job's tears 2.70% v/v. In addition, sake produced with non-dehulled Job's tears showed a slightly higher total phenolic content 16.70 g GAE/g than that produced with dehulled Job's tears 16.42 g GAE/g, and also exhibited higher antioxidant activity, with %inhibition values of 36.15 and 35.05 for non-dehulled and dehulled Job's tears, respectively.

INTRODUCTION

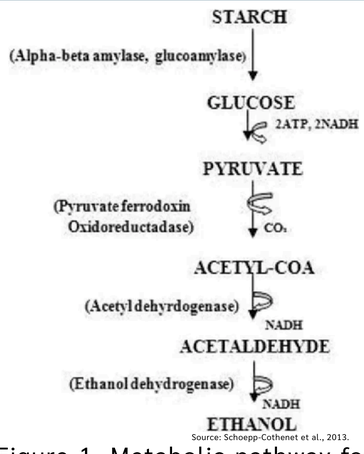


Figure 1. Metabolic pathway for ethanol production from starch.

Sticky millet and Job's tears are nutritious indigenous cereals rich in phenolic compounds and antioxidants. Fermentation can enhance their nutritional value and biological functionality. Sake production using alternative cereals may improve product diversity and functional properties. Therefore, this study aimed to evaluate sake produced from sticky millet combined with dehulled and non-dehulled Job's tears and to investigate the effects of dehulling on fermentation performance and biological properties.

OBJECTIVES

- To investigate sake production from sticky millet combined with dehulled and non-dehulled Job's tears.
- To evaluate changes in chemical and bioactive properties.
- To assess the effect of Job's tears dehulling on sake quality.

METHODOLOGY

SAKE FERMENTATION PROCESS

Raw materials preparation



Sticky millet 50 g
Boil 3 min → Rinse → Cool

Job's tears 100 g
Soak 4–6 h → Boil 20 min → Rinse → Cool

Mixing & Inoculation



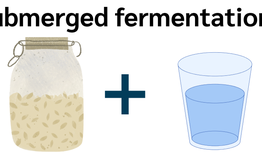
Sticky millet 50 g, Job's tears 100 g, and **starter culture 1.02 g** were mixed thoroughly and packed into fermentation containers.

Solid-state fermentation



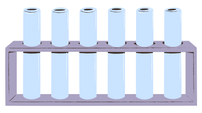
The mixture was fermented for **7 days at 25–30 °C.**

Submerged fermentation



Drinking **water 350 mL** was added, and fermentation was continued **until day 13.**

Sampling & analysis



Collected 10.0 mL samples on **days 0, 1, 3, 5, 7, 9, 11, and 13.**

Filtration



The fermented liquid was filtered.

Pasteurization



The filtrate was pasteurized at 60 °C for 30 min.

Bottling

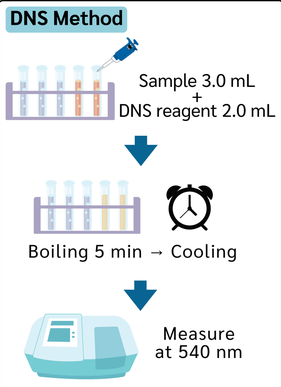


The pasteurized product was bottled.

PROPERTIES ANALYSIS

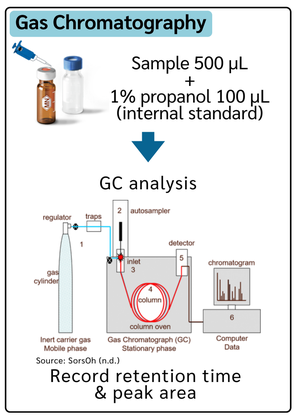
Reducing Sugar Content

DNS Method



Ethanol Content

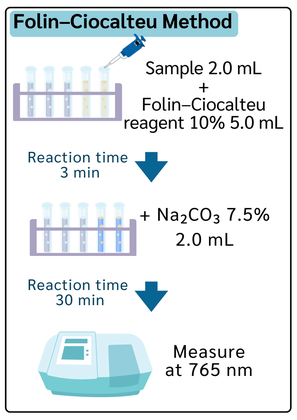
Gas Chromatography



Record retention time & peak area

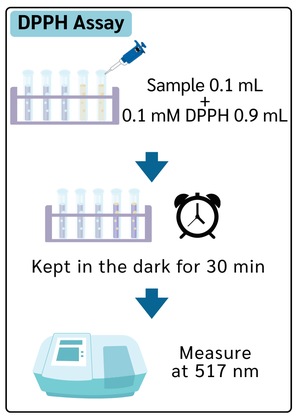
Total Phenolic Content

Folin–Ciocalteu Method



Antioxidant Activity

DPPH Assay



RESULTS & DISCUSSION



Figure 2. Fermented sake from sticky millet and dehulled or non-dehulled Job's tears.

Sticky Millet + Dehulled Job's Tears

Produced sake with lower ethanol content, milder alcoholic aroma, and smoother, lighter taste, with slightly lower bioactive properties, making it more pleasant and easy to drink.

Sticky Millet + Non-Dehulled Job's Tears

Produced sake with higher ethanol content, stronger alcoholic aroma, and richer flavor, along with higher phenolic content and antioxidant activity, resulting in a full-bodied taste and slightly bitter aftertaste.

REDUCING SUGAR AND ETHANOL CONTENT

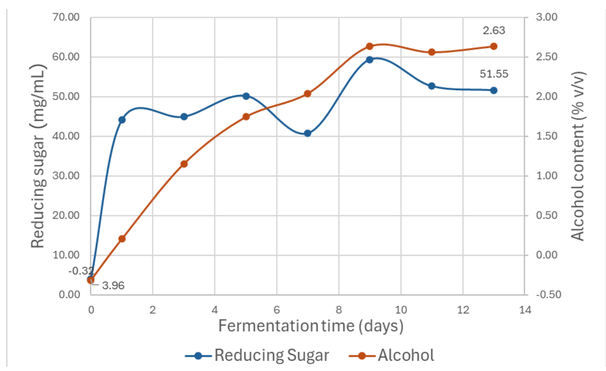


Figure 3. Reducing sugar and ethanol contents of sake from **sticky millet and dehulled Job's tears.**

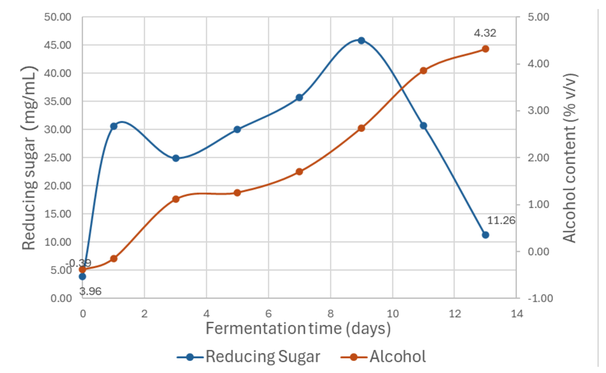


Figure 4. Reducing sugar and ethanol contents of sake from **sticky millet and non-dehulled Job's tears.**

TOTAL PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY

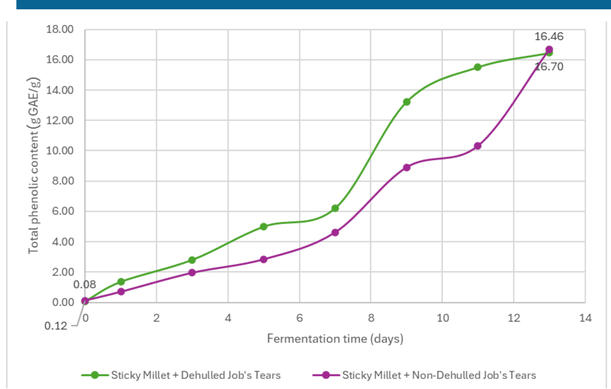


Figure 5. **Total phenolic content** of sake from sticky millet with dehulled and non-dehulled Job's tears.

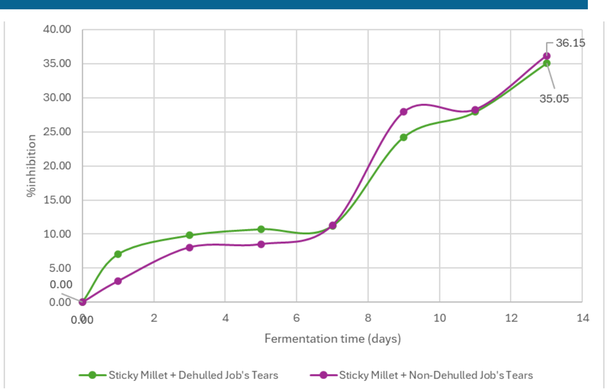


Figure 6. **Antioxidant activity** of sake from sticky millet with dehulled and non-dehulled Job's tears.

CONCLUSIONS

- Sticky millet and Job's tears can be effectively used as **alternative raw materials** for **sake production**, providing acceptable **fermentation performance** and **product quality**.
- The use of **non-dehulled Job's tears** resulted in **significantly higher ethanol content (4.31% v/v)** compared with **dehulled Job's tears (2.70% v/v)**, indicating **improved fermentation efficiency**.
- **Total phenolic content (16.70 vs. 16.42 g GAE/g)** and **antioxidant activity (36.15% vs. 35.05% inhibition)** were slightly higher in sake produced from **non-dehulled Job's tears** than in **dehulled samples**.
- These results demonstrate that the **dehulling process** plays a **critical role** in determining **fermentation performance, bioactive properties, and overall quality** of the final sake product.

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