Effect of Different Sweet Sorghum Storage Conditions on Ethanol Production

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Abstract

Preservation of the sugar has been a major concern in the bioprocessing of sweet sorghum. The present study attempted to establish a simple and feasible storage method for sweet sorghum by testing different storage temperature with/without the additive of nitrogen (N_2). The effects of temperature and N_2 on the changes of the fermentable sugars during the sweet sorghum storage process were investigated. Three temperatures including Room Temperature (RT), 4°C, 20°C with/without N_2 were tested. The fermentable sugar content and the ethanol yield were used to evaluate the storage condition. The ANOVA shows that temperature is the more predominant factor in inhibiting the sucrose degradation compared to N_2 for a longer preservation. After 112 days' storage, 126.75 mg/g DW (Dry Weight) and 121.2 mg/g DW sucrose were obtained in the sweet sorghum which was stored at20 with/without N_2, respectively, much higher than those at RT and 4 with/without N_2. A similar trend was observed on the variation of glucose and fructose content in the sweet sorghum during the storage. The remarkable increase of glucose and fructose content was observed due to the rapid degradation of sucrose in sweet sorghum within the first two weeks. The ethanol production of 16.54 g/100g DW was achieved in the feedstock stored at -20°C for 112 days, corresponding to 85.4% of that from the fresh feedstock.

Keywords: Sweet sorghum; Storage; Glucose/fructose content; Sucrose Degradation; Fermentation; Bioethanol

Introduction

More emphasis has been given on the conversion of biomass to bioethanol because of the increasing demand for alternative fuels [1-3]. Sweet sorghum (

Beijing, China). Some of the bags were filled with N_2 (99.5% with H_2O ≤ 15ppm). The sealed bags were then stored at six different conditions as following: Room Temperature (RT) with/without N_2; 4 with/without N_2; -20 with/without N_2. Duplicates were run for each condition.

After being stored for 14 days, 28 days, 56 days, 84 days and 112 days, the sweet sorghum was taken out and milled by a grinder (FZ102, Tianjin Taisite Instruments Co., Ltd, Tianjin, China) and the milled sweet sorghum was used for the ethanol fermentation test.

Fermentation

Yeast activation: The fermentation was carried out with 20 g (Dry Weight, DW) milled feedstock from 2.2, 0.5% (W/DW) activated ADY (Angel Yeast Co., Ltd. Yichang City, Hubei Province, China), 0.1 g $(NH_4)_2SO_4$, 0.1 g $CaCl_2$, and supplementation of tap water which brought the total weight to 100 g. Nitrogen was filled and fermentation locks pre-filled with glycerol were mounted on the 100 ml fermentation bottle. The fermentation was performed at 32. The amount of ethanol produced was determined as weight loss caused by CO_2 release. All the fermentations were done in triplicate.

After fermentation, 10 times of the distilled water was added and then incubated at 80 for 1h. The supernatant was used to determine the sucrose, glucose and fructose.

Analysis methods

Dry matter content: Dry matter content was determined by the moisture analyzer, Mettler Toledo HR83. Duplicate experiments were run for each sample.

Chemical composition analysis: The sucrose, glucose, and fructose of stored/fresh sweet sorghum were determined by HPLC.

HPLC analysis: The amounts of sugar monomers were measured by HPLC (Agilent technologies, 1260 Infinity) using a Hi-Plex-Pb Column (Strong cation exchange resin consisting of sulfonated cross-

Changes on glucose and fructose content in sweet sorghum stored at different conditions

Figure 2A and 2B present the changes on glucose and fructose content in the sweet sorghum stored at different conditions, respectively.

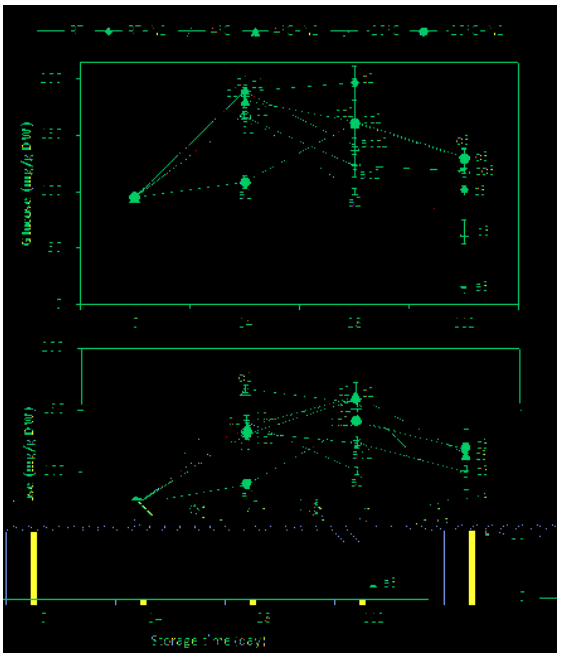

Figure 2: Changes on glucose and fructose in sweet sorghum storage process: data points within a group (with the same Arabic numbers) followed by the same letter are not significantly different according to the Duncan's multiple range test (A=glucose, B=fructose).

The trend for glucose and fructose content change in the storage process was related to the degradation of sucrose. In the first 14 days, the glucose and fructose content in the feedstock increased except for that in the feedstock stored at -20 with N2 which showed a minor decrease. As the storage was extended from 14 to 28 days, the glucose content in the feedstock stored at -20 with N2 showed a sharp increase, while it decreased for the other storage conditions. Compared with glucose content, fructose content reached its peak at 28 days when the N2 was introduced to the storage process. For the feedstock shoq

feedstock for the biorefinery plant. A lower temperature is satisfactory to conserve the sucrose even without N_2 in the storage process. The suitable temperature for sweet sorghum was -20°C and the total sugar remained as high as 93.7% of the original after 112 days' storage. The maximum ethanol production of 16.54 g/100g DW was obtained in the feedstock stored at -20°C for 112 days, corresponding to 85.4% of that from the fresh feedstock.

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