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SSF production of L-lactic acid from food waste and sophoraflavescens residues

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Abstract

L-lactic acid (L-LAC) production by simultaneous saccharification and fermentation (SSF) of food waste (FW) and sophoraflavescens residues (SFR) at different FW-to-SFR (FSRs) ratios (i.e., 0:1, 0.5:1, 1:1, 1.5:1, 2:1 and 1:0) was investigated. Results from the experiments revealed that co-fermentation of SFR and FW produced more amounts of L-LAC compared with the exclusive fermentation of SFR or FW under the same amount of fermentationsubstrate.It may be attributed to the synergistic effect of the co-fermentation. The highest L-LAC yield was obtained at theFSRsof1.5:1. Besides, experimental results also suggested that the addition of SFR into the fermentation substrate could alleviate the acidification of FW and reduced the yield of the adverse by-products (i.e., ethanol) as well. On the other hand, addition of FW might support nitrogenresourceforLactobacillus casei, minimizing the cost for other nitrogen supplemental raw material (e.g., the yeast extract). The study results provide an important theoretical basis on the resource utilization of FW and SFR.

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Keywords:Food waste; Sophora flavescens residues; L-lactic acid; SSF;Co-fermentation

1. Introduction

Lactic acid is used as a monomer in the preparation of polylactic acid, a type of environment-friendly alternative to petrochemicals plastics [1-3]. Generally, the starchy materials like corn, rice, wheat, barley and so on, are the preferred carbon sources used in lactic acid production at present[4, 5]. However, in some countries, grain is not advocated to be used as industrial lactic acid because of its high price and short supply. Non-grain raw material

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such as FW and SFR used in fermentative production greatly drew large number of researchesattentions[6, 7].

It is reported that over 10 million tons of herbal-extraction process residues per year are produced as a by-product of traditional Chinese herbal medicines[8]. Herbal-extraction residues usually contain active ingredients and other elements, such as crude fibre, starch, crude fat, crude protein, and so on. Among them, SFR, a typical traditional Chinese medicine residues, was disposed by burying it into soil or using it as livestock feed, which caused widespread environmental and safety concerns[9]. Therefore, it is necessary to find an environmentally friendly alternative for its new uses and to increase its added value. It is a good choice to put SFR as a carbon resource for fermentation. In general, the yeast extract is used as nitrogen source, but the price is tooexpensive, accounting for about one-third of the total cost of the raw material[10]. Unfortunately, there has not report about the co-fermentation of FW and SFR.

The aim of this study was to use FW in place of yeast as a nitrogen source for lactic acid fermentation of SFR and investigate the influence of different FSRs on L-LAC production.

2. Materials and methods

2.1. Raw materials

FW was collected from the dining room of University of Science and Technology of Beijing, and SFR was from a traditional Chinese pharmaceutical factor in Shanxi Province, China. The chemical characteristics of the substrates are shown in Table 1.

Table 1.Composition of the raw materials.

Parameter	FW (TS)	SFR (TS)
TS (%)	22.57	91.04
VS (%)	93.91	98.36
C/N	18.02	30.56
Cellulose (%)	12.55	38.33
Hemicellulose (%)	4.87	23.61
Lignin (%)	2.91	14.57
Ash (%)	1.77	3.55

2.2. Microorganism, media and culture conditions

The organism used in this study, Lactobacillus casei (6106), was purchased from the China Centre of Industrial Culture Collection, Beijing, China. Industrial cellulose (50000u/g) and amylase (10000u/g) were bought from Beijing DonghuaQiangsheng Biotechnology, Beijing, China. The growth medium contained the following components (g/L): peptone 10, yeast extract 5, ammonium citrate dibasic 2, glucose 20, KH2PO4 2 and MgSO4 0.58. The strains were grown at a temperature of 35℃ and pH of 6.2. The microorganism was cultured for 24h before it was used in the fermentation.

2.3. Simultaneous saccharification and fermentation (SSF)

Flask experiments were carried out in 250ml Erlenmeyer flasks containing 150ml fermented liquid, and total solid-liquid ratio was 1:9. Firstly, 8% NaOH (10^{-2}g/g dry SFR) and water were added into SFR for 24h at 35℃ to pretreat SFR. After pretreatment, FW on the basis of different mixing ratio (0.5:1, 1.25:1, 2:1) was added, and then 8% (v/v) L. casei was inoculated in the fermentation bottle. Besides, cellulose and amylase were added. The mixture was mixed thoroughly by shaking for 1 min. The samples were cultivated at 35 ℃ and shaken at 140 rpm for SSF. Samples (5ml) were obtained every 24h. All the experimental groups were conducted in the anaerobic condition.