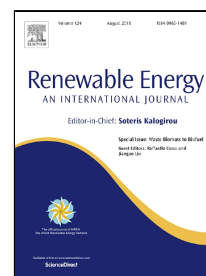


# Accepted Manuscript

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# 1 Dual-Frequency Ultrasound Combined with Alkali Pretreatment of Corn Stalk 2 for Enhanced Biogas Production

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8  
9 **Abstract:** To solve the problem of standing wave produced by single-frequency ultrasonic pretreatment, the dual-  
10 frequency ultrasound was applied to pretreat the corn stalk. In this paper, the mechanism of dual-frequency ultrasound  
11 was studied, and digital simulation results showed that the cavitation of dual-frequency ultrasound was more violent than  
12 that of single-frequency ultrasound, and its energy was more efficient. The anaerobic fermentation of corn stalk that was  
13 pretreated by dual-frequency ultrasound combined with alkali(Group 1) lasted for 53 days. The results showed that the  
14 cumulative biogas yield of Group 1 was 11.1%, 28.2% and 56.6% respectively higher than that of single-frequency  
15 ultrasound combined with alkali pretreatment(Group 2), alkali pretreatment(Group 3) and without pretreatment(Group  
16 4). The TS removal rate of Group1 was 9.9%, 25.0% and 71.4% respectively higher than that of other pretreatment  
17 samples, and the VS removal rate was 7.4%, 28.9% and 77.1% respectively higher than that of other group samples. The  
18 net energy of Group 1 was 32.2%, 114.9% and 19.7% higher than that of Group 2, Group 3 and Group 4.

19 **Key Words:** Corn stalk; Dual-frequency ultrasound pretreatment; Combined pretreatment

## 20 1 Introduction

21 According to the statistics, the planting area of corn as a traditional crop in China is about 3.7 million hectares in 2014,  
22 and corn stalk produced is up to 2.78 billion tons [1]. Most of the corn stalk was disposed or burned carelessly, which  
23 caused great environmental pollution and waste of resources. The utilization of the corn stalk to produce biogas can reduce  
24 the environmental problems that are caused by burning of the stalk [2]. Moreover, biogas fermentation can kill  
25 pathogens(such as *Cochliobolus heterostrophus*, *Helminthosporium maydis*, spoilage bacteria [3]) and pests eggs( such as  
26 eggs of corn borers, armyworms and cotton bollworm on the corn stalk), which can avoid the crop pests and diseases caused  
27 by returning corn stalk directly into fields.

28 Anaerobic digestion for biogas production is one of the most widely used method of biomass energy conversion [4].  
29 However, the cell wall structure of corn stalk is complex and corn stalk is difficult to be used directly by anaerobic  
30 microorganisms. Therefore, it is necessary to pretreat the stalk before anaerobic digestion and the aim of the pretreatment  
31 is improving the efficiency of anaerobic fermentation [5-6]. The most common pretreatment methods are chemical,  
32 physical, biological pretreatment as well as combined pretreatment [7-10]. Chemical pretreatment can change the  
33 microstructure and chemical compositions of lignocellulose in corn stalk significantly, and can make stalk more accessible  
34 and biodegradable to the anaerobic microorganism, which can increase digestion efficiency and biogas yield [11].

35 Alkali pretreatment [12], which is a method of chemical pretreatment, has become increasingly mature and it has been  
36 used in many large and medium-sized biogas projects. The solid anaerobic digester gas production increased by 37% using  
37 5% NaOH pretreatment of corn stalk [13]; biogas production increased by 100.91% using 8% Ca(OH)<sub>2</sub> pretreatment of  
38 rice straw [14]. Ultrasonic pretreatment is a kind of physical pretreatment method [15]. In recent years, ultrasonic  
39 pretreatment combined with other pretreatment methods to improve anaerobic fermentation has gradually attracted the  
40 attention of scholars. Single-frequency ultrasound combined KOH pretreatment method was applied to sewage sludge  
41 anaerobic fermentation [16]. Single-frequency ultrasound combined propionic acid pretreated wheat straw can improve

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