UTILIZATION OF GAMMA IRRADIATION FOR BIOFUEL PRODUCTION BY MICROORGANISMS

By

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B. Sc. (Agric. Microbiology), Ain Shams University, 2005

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ABSTRACT

Marwa Mohammad Mohammad Moussa: Utilization of Gamma Irradiation for Biofuel Production by Microorganisms. Unpublished M.Sc. Thesis, Department of Microbiology, Faculty of Agriculture, Ain Shams University, 2014.

With the growing crisis in fossil fuel and environmental pollution problems worldwide, bioethanol has become one of the most promising biofuels and many studies have been focused on improving the efficacy of the bioethanol production process.

Due to the high cost of bioethanol production process, this work was concerned with producing bioethanol from low-cost raw agro-industrial feedstock and utilizing gamma irradiation technology to increase conversion efficiency of these materials to bioethanol. Sugarcane bagasse and potato peels were hydrolyzed by dilute sulphuric acid (2 and 6 % v/v) and the resulted hydrolyzates were fermented by either *Zymomonas mobilis* ATCC 29191, *Saccharomyces cerevisiae* ATCC 7754, or co-culture of both organisms. The effect of gamma irradiation on bioethanol production was studied by exposing the producing microorganisms or feedstock to different doses of γ-rays. Effect of combined treatment of feedstock, using gamma irradiation and dilute acid, on bioethanol production was also investigated.

Gamma irradiation had negative impact on cell counts, but not the viability, of both organisms. The highest bioethanol production, from acid-hydrolyzed sugarcane bagasse, was from treatment with 2 % (v/v) H_2SO_4 at 120°C for 60 min, fermented with *Sacch. cerevisiae* (irradiated at 0.3 kGy), giving 10.3 g L^{-1}. The highest bioethanol production, from acid-hydrolyzed potato peels, was from treatment with 6 % (v/v) H_2SO_4 at 100°C for 30 min, fermented with *Sacch. cerevisiae* (irradiated at 0.3 kGy), giving 7.5 g L^{-1}.

On sugarcane bagasse, hydrolyzed with 2 % (v/v) H_2SO_4 at 120°C for 60 min, the co-culture of *Z. mobilis* irradiated at 0.1 kGy and *Sacch. cerevisiae* irradiated at 0.3 kGy produced 11.3 g L^{-1}. When the last pretreatment was preceded with irradiation of sugarcane bagasse at 75 kGy, 15.6 g L^{-1} of bioethanol was achieved.

On potato peels, hydrolyzed with 6 % (v/v) H_2SO_4 at 100°C for 30 min, the same co-culture of irradiated *Z. mobilis* at 0.1 kGy and *Sacch. cerevisiae* at 0.3 kGy produced 9.2 g L^{-1} of bioethanol. When the last pretreatment was preceded with irradiation of the potato peels at 75 kGy, 12.1 g L^{-1} of bioethanol was achieved.

Key Words: Bioethanol, fermentation, sugarcane bagasse, potato peels, dilute acid hydrolysis, gamma irradiation, co-culture, *Saccharomyces cerevisiae*, *Zymomonas mobilis*.

CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DE	Dextrose equivalent
d.w.	Dry weight
ED	Entner-Doudoroff pathway
EMP	Embden-Meyerhof-Parnas pathway
HMF	5-Hydroxyl-methyl-furfural
kGy	Kilogray
NO_x	Nitrogen Oxides
PPW	Potato peel waste
RFA	Renewable Fuels Association
rpm	Round per minute
t/ha	Ton per hectare
UV	Ultraviolet rays
γ-rays	Gamma rays