Production of bio ethanol from waste potatoes

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Abstract. In this research, production of ethanol from waste potatoes fermentation was studied using Saccharomyces cerevisiae. Potato Flour prepared from potato tubers after cooking and drying at 85°C. A homogenous slurry of potato flour prepared in water at solid-liquid ratio 1:10. Liquefaction of potato starch slurry was done with α-amylase at 80°C for 40 min followed by saccharification process which was done with glucoamylase at 65°C for two hr. Fermentation of hydrolysate with Saccharomyces cerevisiae at 35°C for two days resulted in the production of 33 g/l ethanol. The following parameters have been analysed: temperature, time of fermentation and pH. It found that Saccharification process is affected by enzyme Amylase 300 concetration and concentration of 1000μl/100ml gives the efficient effect of the process. The best temperature for fermentation process was found to be about 35oC. Also, it noticed that ethanol production increased as a time of fermentation increased but after 48 hr further growth in fermentation time did not have an appreciable effect. Finally, the optimal value of pH for fermentation process was about 5 to 6.

1. Introduction

Bioethanol as an alternative source of energy has received particular attention worldwide due to depletion of fossil fuels. From the 18th century to the beginning of this century, significant discoveries about the biology and chemistry of fermentation and distillation made it possible to produce cheaper ethanol from a variety of organic materials [1, 2].

The two critical processes followed. First, the starch or hemicelluloses and cellulose portions of the biomass are broken down into simple sugars through a process called saccharification. Second, the sugars are fermented to produce ethanol [3, 4].

Sugar substrates available are comparatively expensive than molasses but can easily use for ethanol production with some modification in the process. On the other hand, cellulose materials are cheaper and available in plenty, but their conversion to ethanol involves many steps and is expensive. The starchy substrates are promising due to their economic viability and availability. Starchy crops like corn, barley, wheat, rice and tuber crops viz. potato, sweet potatoes are being exploited for the production of bioethanol worldwide since it is rich in starch, which makes it the second substrate for ethanol production. The problems associated with its processing will also be less than in other grains. It is also semi-perishable food which can store for a considerable period without spoilage. Good quality alcohol can produce from potato which can use for fuel. The purpose of this research was to
explore the parameters and operating conditions that give the best conversion of potato starch into ethanol [4, 5, and 6].

2. Experimental work

2.1. Material and Methods

2.1.1. Potato preparation. Waste of potato brought from chips factory and restaurants. 1 kg waste potatoes were cooked with two liters water in a pressure cooker at 85 °C for one hour then it dried overnight in an oven at 70°C and mashed to a fine powder (0.3mm).

2.1.2. Preparation of potato slurry. slurries prepared from potato powder mixed with water at a ratio (1:20 w/w). The slurry was treated with amylase enzyme (1000μl/100ml) at 80 °C for 40 min under shaking conditions.

2.1.3. Analysis of waste potatoes. Waste of potatoes contained 77% moisture, 18.2% starch, 2.4 % proteins and 0.6% total sugars while the respective hydrolysate of potato was 13.2, 70, 10.8, 1.5 and 4.5% (Table 1).

2.1.4. Saccharification of slurry. Saccharification of the slurry was carried out at 65°C for two hr using Amy 300 enzyme of concentration (1000 μl/100ml). The reaction monitored by the yield of total reducing sugars estimated by dinitro salicylic acid method [7].

2.1.5. Effect of enzyme concentration. The liquefied potato flour saccharified with different levels of Enzyme Amy 300 (600, 800, 1000 μl/100ml) at 65°C. The reaction monitored by the yield of total reducing sugars which estimated by dinitro salicylic acid method [8].

2.1.6. Yeast culture. A fast fermentation strain of Saccharomyces cerevisiae was maintained on yeast extract peptone dextrose agar medium containing in grams per 100ml ( potato starch 10; peptone 0.1; malt extract 0.1 ; yeast extract 0.2; magnesium chloride 6H2O 0.1; calcium carbonate 0.2 ; ammonium phosphate 0.2 ; ferrous sulphate .7H2O 0.001). Yeast cells were grown in inoculums medium at 35°C for 20 hr under shaking condition (100 rpm) and centrifuged at 8000 rpm for 20 min. For testing the effect of pH on fermentation few drops of 1N HCl or 1N NaOH were added to this medium to obtain the desired initial pH [8].

2.1.7. Fermentation of potato's hydrolysate. The hydrolysate of potato inoculated with Saccharomyces cerevisiae of 0.8% concentration (w/v) at 35°C. Ammonium sulfate of 0.2% concentration (w/v) added as a source of nitrogen. Flasks incubated at 35°C under the stable condition for 96 hr and ethanol content measured at an interval of 24 h by gas-liquid chromatography (GC 8200) using capillary column and flame ionization detector.

3. Results and discussion
3.1. Effect of Concentration

Fig. (1) shows that as enzyme concentration increased the total reducing sugar also increased and level of 1000 μl/100ml gave practical effect in saccharification. This behavior caused by the higher growth rate of microorganisms at high values of inoculum concentrations which lead to higher rate of organic matters degradation in the process. This finding is in agreement with that found by Nagoda, T [9].

![Figure 1. Effect of Amy concentration on Saccharification on hydrolysate at 65 °C](image)

Fermentation of 30% slurry of potato hydrolysate was carried at different temperatures (25, 30, 35, 40 °C) under stable conditions up to 48 hr. Fig. (2) shows that fermentation at 35°C gives the maximum content of ethanol of 32 g/l. Due to the effect of temperature on the activity of the microorganisms.

![Figure 2. Effect of temperature on ethanol production (Enzyme Conc. =1000μl/100ml,Time of fermentation = 48 hr, pH=5.5)](image)

It knew that temperature above 40°C affects the membrane composition of microorganisms, e.g. the phospholipids fatty acid composition changes with temperature and hence affects the enzymatic system of the organisms [10].
3.2. Effect of Time Fermentation

Fermentation of potato hydrolysate was carried out at 35 °C for different time intervals using enzyme concentration (1000μl/100ml) of Amy 300 containing amyloglucosidase. Fig. (3) shows that ethanol production increased as a time of fermentation rose from 24 to 48 hr, so it reached to 32g/liter at 48hr; however, further growth in fermentation time did not have an appreciable effect. This result is in agreement with that mentioned by Wang F [11] and Oner [12].

![Figure 3](image)

**Figure 3.** Effect of fermentation time on ethanol production (Enzyme Conc. =1000μl/100ml, Temp =35oC, pH =5.5)

3.3. Effect of pH

Figure (4) shows that the production of ethanol has increased with increasing pH from 3 to 6, the optimal production of ethanol was 32g/l which occurs at pH 6. After that, the production began to decrease with increasing pH and reached to 22 g/l at pH 8. This behavior can interpret by the effect of pH on the activity of α Amy enzyme, since the business of this protein is severely affected by the value of pH especially at the value of pH > 6 [8].

![Figure 4](image)

**Figure 4.** Effect of pH on ethanol production (Enzyme Conc. =1000μl/100ml, Temp. =35oC, time of fermentation=48hr)
4. Conclusions
1) Saccharification process is affected by enzyme Amy 300 concentration and concentration of 1000μl/100ml gives practical effect on the process.
2) The best temperature for fermentation of potato starch to produce ethanol using Saccharomyces cerevisiae is about 35°C.
3) Ethanol production increased as a time of fermentation rose from 24 to 48 hr; however further growth in fermentation time did not have an appreciable effect.
4) The optimal value of pH for the fermentation process to produce ethanol production was about 6.

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