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# Process Optimization of Bio -Ethanol Production through Cashew Apple Juice Fermentation

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**Abstract:** The cashew apple (or cashew fruit) is the fleshy part of the cashew fruit that is attached to the cashew nut. Cashew apples are extremely soft and easily bruised in shipment. For this reason, cashew apple are converted into cashew juice and cashew juice concentrate. Cashew apple contains higher concentration of sugar content which ranges from 162.7 to 168.1 g/l. Hence the presence of sugar contents offers a wide potential for its conversion to ethanol. The aim of the present study is to optimize the process variables for the fermentation of cashew apple using microorganisms. The influencing process parameters that effect the percentage conversion of ethanol are pH, temperature of fermentation, time and agitation speed. The experiments are conducted with pH ranging from of 4 to 8, temperature is varied in the range of 30-45°C and fermentation time is varied in the range of 24 to 36 hours. The experiment is carried at static and agitated conditions. The process of conversion of cashew apple into ethanol by fermentation is optimized.
**Key words:** cashew apple, kinetics, ethanol, microorganism, fermentation.

## Introduction

The cashew apple (or cashew fruit), is the fleshy part of the cashew fruit that is attached to the cashew nut. The cashew apple is a soft fruit, rich in nutrients and contains five times more vitamin C than an orange. Cashew apples have a sweet but astringent taste. This astringency limits the direct consumption of fresh fruit. Also the fruit, unlike the Cashew nut, is difficult to transport as they are extremely soft and easily bruised. For this reason, cashew apple are converted into cashew juice and cashew juice concentrate. Alternatively it can be fermented into an alcohol.

Cashew apple is a predominant waste produced during the recovery of cashew nut for public consumption. The cashew apple is found to be rich in sugar content offering a wide potential for its conversion to ethanol. Total sugars contents range from 162.7 to 168.1 g/L [1]. The wet pulp contains sufficient moisture content that enhances its microbial degradation. The aim of the present study is to optimize the process variables for the fermentation of cashew apple using microorganisms. The various parameters that influenced the fermentation processes are pH, temperature and time of fermentation.

## Materials and Methods

### Extraction of cashew apple juice

The cashew apple was collected from various fields in and around Cuddalore, TamilNadu, India. The collected cashew apple was cut into small slices to crush them easily. The slices were then ground for its juice extraction. The tannin and suspended solids were clarified by addition of 1% gelatin [2]. This was followed by

centrifugation at 3500 rpm for 20 min, addition of 2.5 g/L of ammonium sulphate, and sterilization at 121°C for 15 min the juice sample was preserved at 4°C for further experimentation.

**Microorganism and Fermentation medium**

The microorganism *Saccharomyces cerevisiae* was bought from MTCC, Chandigarh. The yeast stock culture was maintained on potato dextrose agar slants of following composition in grams per liter; dextrose-20.0; peptone-1.0; and agar- 20.0. The culture was periodically subcultured to maintain the cultures active and suitable for fermentation [2]. The medium component was chosen as yeast extract (3 g) as it was supposed to give the maximum conversion amongst other medium supplements [2].

**Fermentation Process**

The fermentation process was carried out in 250 ml Erlenmeyer flasks under aerobic conditions. The whole process of fermentation was performed in an incubator under static and shaking conditions. The samples were withdrawn at regular intervals, centrifuged and analyzed for ethanol concentration as per standard methods [3].

## Results and Discussion

The various parameters that influenced the fermentation processes are:

- pH
- Time of fermentation
- Temperature
- Agitator speed.

The fermentation process was carried out over a wide range of pH from 4 to 8. From the results, shown in figure1, the optimal pH was found to be 6.5.

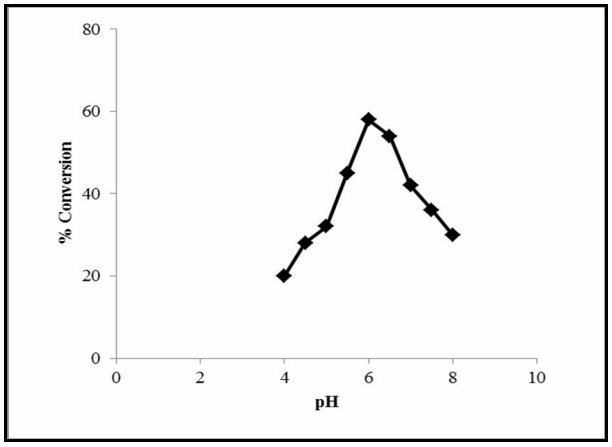


**Figure 1: Effect of pH on the percentage conversion of ethanol**

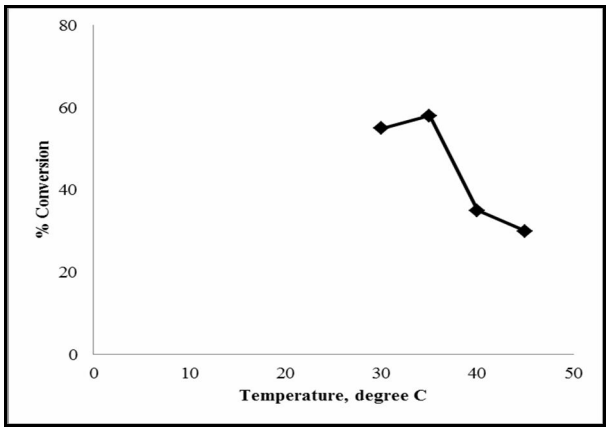


**Figure 2: Effect of temperature on the percentage conversion of ethanol**

With the optimized pH at 6.5, which is maintained constant; the experiment was carried out to optimize temperature. The incubation temperature was varied from of 30 to 45°C. It was found to be 35°C that is shown in the form of graphical representation (figure 2). The reason might be attributed to the fact that at higher temperatures the yeast might have been deactivated.

The experiment was now carried out to optimize time of fermentation with the pH and temperature constant at 6.4 and 35°C. The trial experiments were carried out between 24 and 36 hours.

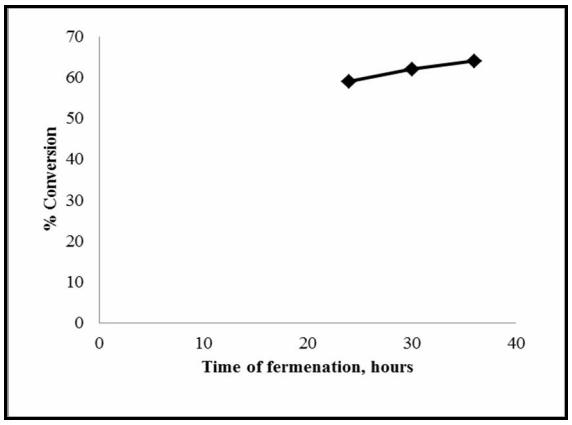


**Figure 3: Effect of time of fermentation on the percentage conversion of ethanol**

The experimental results show that the maximum conversion of cashew apple to ethanol was achieved at 30 hours, shown in figure 3. The fermentation was tested for its conversion under static and agitated conditions and it was found that the conversion was more when it was carried out under shaking conditions and high conversion was found to be when it was shaking at 150 rpm.

## Conclusion

The process variables influencing the bio-ethanol production through cashew apple juice fermentation was optimized with pH at 6.5, temperature at 35°C and time of fermentation as 30 hours. The process produced best results at shaking conditions rather than static condition.

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