

Eichhornia crassipes- A Menace to Fresh Water Bodies and Its Sustainable Ethanol Extraction: Mini Review



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Abstract

Water Hyacinth is a menace to fresh water bodies in the tropics and causes serious treats to the water quality by affecting its ecology. This mini-review highlights the process of ethanol extraction from its biomass for use as an alternate fuel. Thus converting the bane to a boon.

Keywords: Water hyacinth; *Eichhornia crassipes*; Water; Fermentation; Ethanol

Introductions

Water hyacinth (*Eichhornia crassipes*), is a free-floating aquatic macrophyte, and is also an invasive planta species found in several parts of the world. It often jams rivers and lakes with tons of floating plant matter [1] which leads to serious problems in navigation, irrigation, and power generation [2]. Under favourable weather conditions, a healthy acre of water hyacinth can weigh up to 200 tons and row to very high density of over 60 kg/m² [3]. Its stems and leaves contain unique aerenchymatous tissue which provides the plant its substantial upthrust; thus preventing the entry of sunlight into water, required for algae and other forms of life [4]. Doubling time of 6 to 18 days has also been reported for Water hyacinth under favourable circumstances [5]. With one of the highest doubling rates of any plant known, its population can double in as low as 12 days [6]. *Eichhornia* growth has been reported in temporary ponds, marshes and sluggish flowing waters to large lakes, rivers and reservoirs [2].

The reason for this tremendous growth rate is probably that, it can tolerate wide variation in nutrients, temperature and pH levels. The optimum pH for growth of water hyacinth is 6 to 8 and it can tolerate temperatures ranging from 10 to 40 °C [7,8].

Discussion

The process of conversion of *Eichhornia* biomass into fuel ethanol (bioethanol) involves the following steps [9].

Preparation of water hyacinth

summarizes the steps in preparation of *Eichhornia* for ethanol extraction (Figure 1).

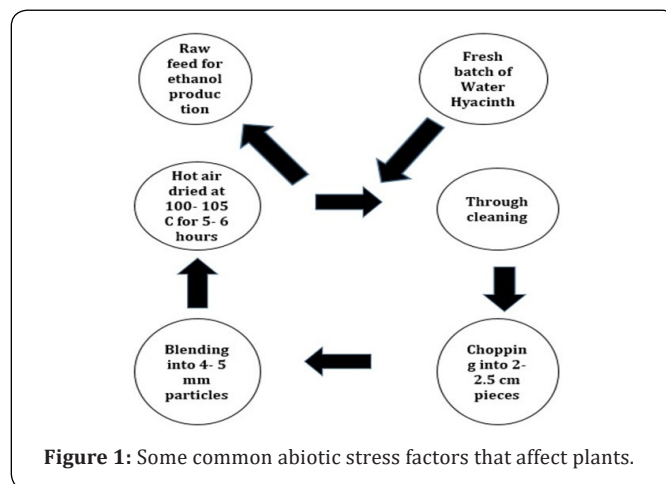


Figure 1: Some common abiotic stress factors that affect plants.

Pretreatment

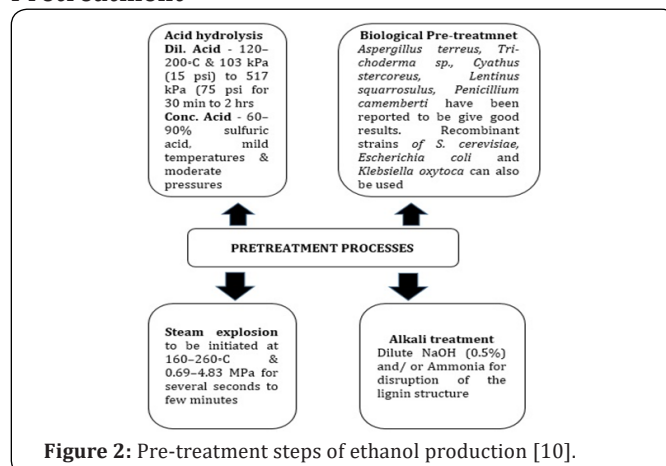


Figure 2: Pre-treatment steps of ethanol production [10].

Pretreatment of lignocellulosic materials is carried out to increase the surface area followed by breakdown into simpler sugars. Details of various types of methods are shown in (Figure 2).

Cultivation and activation of microorganisms

In the ethanol production process, the most efficient microorganism should be chosen after determination of the process type and equipment. The chosen microorganism should have the following characteristics-

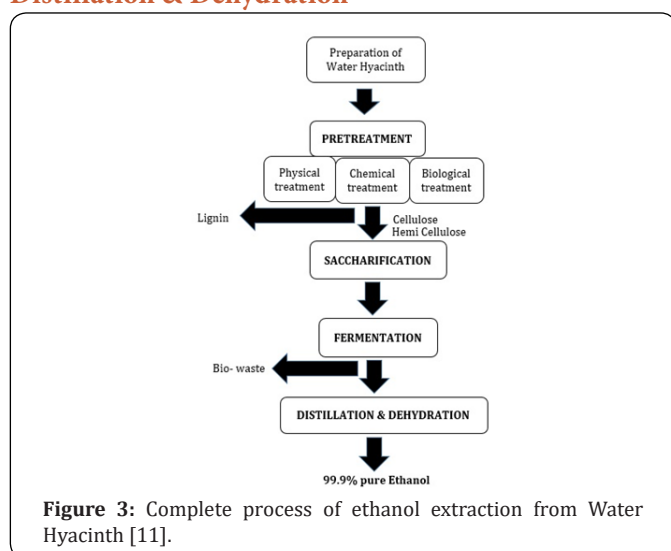
- A. High product yield
- B. Tolerance for low pH values
- C. Tolerance for temperature changes
- D. Saturated ethanol tolerance
- E. Ability to remain stable under fermentation conditions

Saccharomyces cerevisiae, *Clostridium thermocellum*, *Clostridium* and *Pichiastipites* are some of the species commonly used [10-12].

Fermentation

Under anaerobic conditions, microorganisms use the substrate gained from lignocellulosic biomaterials of Water hyacinth. After the completion of the complete fermentation process, bioethanol is produced. Fermentation process occurs by the Embden-Meyerhof-Parnas (EMP) process and glycolytic pathway's enzymes.

Distillation & Dehydration



Ethanol is obtained from the process medium before the last step in the distillation process. Ethanol can easily mix with water (azeotropic mixture) and is obtained by providing suitable conditions. As Ethanol's boiling point is 78.8 °C, it boils away. The distillation column is used to obtain 95% ethanol.

But this percentage is not useful to utilize the ethanol in vehicle engines, hence by using a water retaining column, it is easy to obtain 99.9% water-free ethanol, than can be used as a fuel in vehicles [7,13]. The entire process can be summarized as shown in (Figure 3).

Conclusion

Water Hyacinth is found in abundance across the tropics and has the potential of being put to several uses including extraction of ethanol for being utilized as a fuel. However, ethanol production from this feedstock still has several technical challenges including biomass collection and pre-processing. It has also been observed that decentralized plants prove to be more productive for ethanol production. Studies have also demonstrated that it is possible to achieve around 71% efficiency in saccharification step of ethanol production by using very crude and cost effective methods for pre-treatment and onsite enzyme production. At the same time, Usage of more suitable organisms for fermentation can also improve the yield of ethanol. Technically less intensive operations may be utilized such as employing non-skilled workers in order to reduce the production cost.

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