Marine Fermentation, the Sustainable Approach for Bioethanol Production

Abdelrahman Saleh Zaky
School of Biosciences, University of Nottingham
UK

COLUMN ARTICLE

Current fermentation technologies mainly use edible crops and freshwater for the production of bioethanol and many other valuable compounds such as solvents, enzymes and proteins. With an ever growing population and demand for biofuels and other bio-based produces, there are concerns over the use of the limited freshwater and food crops resources for non-nutritional activities. The main purpose of marine fermentation is to introduce an alternative source of water and biomass for Industrial Biotechnology (IB) in order to reduce pressure on use of freshwater and arable land, allowing these resources to be dedicated to production of food and feeds. Marine fermentation is the approach where seawater, marine biomass and marine microorganisms are used in the fermentation process for the production of value added compounds (Figure 1). By applying marine fermentation, seawater will replace freshwater for biomass production, biomass hydrolysis and fermentation media preparation. The concept of marine fermentation was initially introduced in 2014 by Zaky., *et al* [1].

Bioethanol is one of the most import IB products and can be considered one of the best replacements for petrol because it is a liquid fuel and it has a positive impact on the environment. Worldwide bioethanol production in 2015 exceeded 97 billion litres/year [2,3], contributing approximately 2.4% of the world's fuel consumption for transportation. However, bioethanol has a very high water consumption index, with an average global water footprint of 2855 L H_2O/L EtOH. Therefore, a shift from fossil fuel based economy towards biofuel puts an additional pressure on the limited freshwater resources in many regions of our overpopulated planet. Hence, finding alternative water resources is essential to meet the bioethanol target of 2030 and beyond.

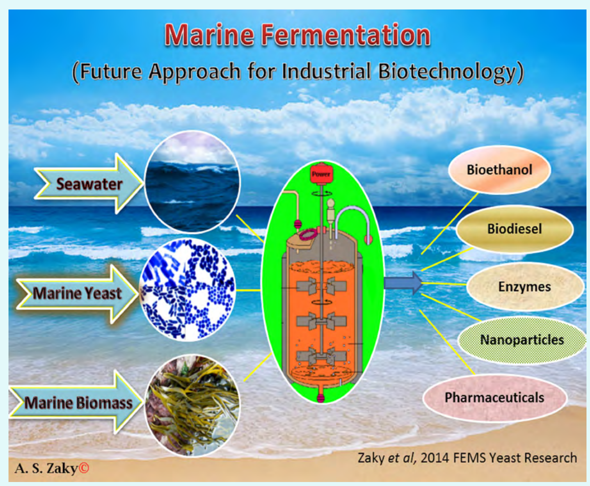

Figure1: Marine Fermentation.

Oceans and seas are sources of abundant water that can be easily accessed in most of arid and semi-arid zones, additionally they can also provide a source of marine biomass that can be used as a substrate for bioethanol production that does not require any freshwater for cultivation. Hence, the development of seawater based media, along with the usage of marine yeast in bioethanol production, can make a valuable impact on overcoming both the freshwater and energy crisis's. However, seawater contains a spectrum of

Citation: Abdelrahman Saleh Zaky. "Marine Fermentation, the Sustainable Approach for Bioethanol Production". EC Microbiology ECO.01 (2017): 25-27.

minerals that inhibit the growth and fermentation ability of the conventional yeast. In addition, obtaining an accurate quantification of sugars using HPLC in samples containing NaCl has proven difficult due to similar retention times for Cl- and sugars, especially glucose and sucrose [4,5]. Therefore, the key requirements for marine fermentation include; a) finding a suitable yeast strain that can tolerate the high concentrations of salts that exist in seawater, b) finding an accurate analytical method for monitoring the substrate and product during the fermentation process. Inconsequence, we have recently devolved Zaky's method for the efficient isolation and evaluation of marine yeasts [6,7]. The method was successfully used for isolating and evaluating number of marine yeast strains with potential industrial application especially for bioethanol production using seawater-based media [8]. In addition, we developed a new HPLC methodology for simultaneously measuring chloride, sugars, organic acids and alcohols in food samples. The method was successfully applied to samples derived from seawater fermentation, as well as many food samples [5].

In freshwater-based fermentation, the production of one litre of bioethanol consumes around 10 litres of water during the fermentation process [9]. Using seawater instead of freshwater for bioethanol production will reduce the WF of bioethanol and potentially convert this process from a high water consuming process to a water producing process. On industrial scale, bioreactors usually contain around 12% ethanol, 12% of solids and 74% water by the end of ethanol fermentation. Theoretically, if seawater was used in the fermentation, roughly 7 litre of freshwater can be obtained with each litre of ethanol produced (Figure 2). The produced water will be of very high quality and therefore can be used in industries that require high quality water or it can be used to enhance lower quality water to produce acceptable drinking water. Further advantages of using seawater in the fermentation for bioethanol production include; a) the minerals in seawater will potentially reduce the need for adding minerals to the fermentation media, b) the production of sea salt as a by-product, c) producing salted animal feed that can be used to eliminate the cost of adding minerals to the animal diets.

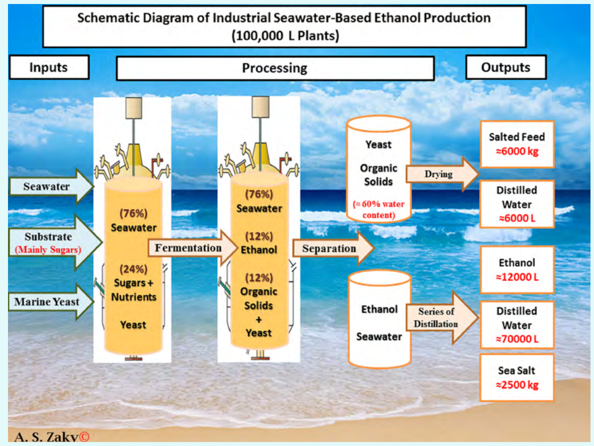

Figure 2: Input-output in seawater-based fermentation at the industrial level.

In addition, the salt content in seawater is not favourable for terrestrial microorganisms and therefore may play a role as a selective agent against microbial contamination in biorefineries, especially for the production of baker's yeast where contamination is a major limiting factor [9,10]. Thus, using seawater in fermentations could potentially improve the overall economics of the process and make a strong impact on overcoming freshwater, food and energy crises.

BIBLIOGRAPHY

1. Zaky AS., *et al*. "Marine yeast isolation and industrial application". *FEMS Yeast Research* 14.6 (2014): 813-825.
2. RFA. World Fuel Ethanol Production (2015).
3. AFDC. Alternative Fuels Data Center (AFDC) (2015).
4. Sims A. "HPLC Analysis of Sugars in Foods Containing Salt". *Journal of Agricultural and Food Chemistry* 43.2 (1995): 377-380.
5. Zaky AS., *et al*. "A new HPLC method for simultaneously measuring chloride, sugars, organic acids and alcohols in food samples". *Journal of Food Composition and Analysis* 56 (2017): 25-33.
6. Zaky A., *et al*. "A New Isolation and Evaluation Method for Marine Derived Yeast spp with Potential Applications in In-

dustrial Biotechnology". *Journal of Microbiology and Biotechnology* 26.11 (2016): 1891-1907.

7. Zaky AS and C Du. "The isolation of novel marine yeasts; a new procedure". *New Biotechnology* 31 (2014): S132.
8. Zaky AS., *et al*. "Use of marine yeast for the efficient production of bioethanol from seawater-based media". *New Biotechnology* 33 (2016): S52-S53.
9. Kyyaly MA., *et al*. "Production of Baker's yeast using seawater-based media". *New Biotechnology* 33 (2016): S71.
10. Nasr NF., *et al*. "Microbiological Quality of Active Dry and Compressed Baker's Yeast Sold in Egypt". *Journal of Pure and Applied Microbiology* 4.2 (2010): 455-462.